AGRICULTURAL ENGINEERING

Established 1920

This journal is owned, edited, and published monthly by the American Society of Agricultural Engineers.

Editorial and advertising departments at the executive office of the Society, Saint Joseph, Michigan. Publication office at Benton Harbor, Michigan.

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SUBSCRIPTION PRICE: To non-members of the A.S.A.E., $3.00 a year in the U. S. and possessions and in Americo-Spanish countries, $3.50 a year in Canada, and $4.00 a year in all other countries; to A.S.A.E. members anywhere, $2.00 a year. Single copies (current), 30 cents each.

POST OFFICE ENTRY: Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921.

CONTENTS FOR NOVEMBER 1940

Volume 21, Number 11

EDITORIALS

Orders of Agricultural Engineering Work

THERE are various orders of agricultural engineering thought and work as distinguished, not by quality or importance, but by the nature of the problems involved and the range of influence of the results. They seem worth defining as an aid to planning, direction, estimation of costs, and values of work proposed or in progress, and to selection of work to be done as public service.

Custom jobs are readily distinguishable as involving the obtaining and analysis of data relative to a specific farm, area, or project; interpretation of the data in relation to established engineering principles and information, to determine what further engineering may be physically possible, economically feasible, or the most advantageous of a number of alternative possibilities; and execution of the resulting plans, if any.

This order of engineering is characteristic of large-scale construction jobs and production planning. It may also be justified as a means of providing special mechanical or electrical equipment not obtainable as items of mass production. Direct benefits are limited to the project in question and must justify the full cost of the engineering involved, as well as other costs. Indirect benefits may accrue to the engineers who do the work, and to others, in the form of knowledge and experience, but these can not be accurately assessed to and collected from the beneficiaries. Also, cost of the engineering is not directly proportional to the scale of the project and is often prohibitive in the case of small-scale projects.

These considerations have limited the usefulness of this order of agricultural engineering. It can often be justified on large farms; on area projects such as drainage, irrigation, or conservation districts; in the development of special-purpose equipment which offers reasonable expectation of extensive use and advantage; and in working out comparatively simple machine adaptations for special use conditions; but not generally on average or small farms or construction projects.

Where this order of engineering cannot be justified on a commercial basis, the justification for doing it on a public service basis, as sometimes requested, should be questioned. There are other orders of agricultural engineering which may be expected to result in greater public service than the preoccupation of government or state-employed agricultural engineers with free custom work for individual farmers on problems not common to large numbers of other farmers.

We do not know of any current cases of such preoccupation, but raise the point for what it may be worth, particularly to young agricultural engineers, because we believe that misguided individuals sometimes ask public service agencies for free engineering service, the benefits of which would be limited largely to themselves. Furthermore, the border line between public and individual service is sometimes indistinct, and a desire to be of service creates a temptation to respond to requests which may not be justified by wide public interest in the results.

A closely related order of agricultural engineering is that in which the actual work is of a custom nature, but where the results may be expected to include benefits extending substantially beyond the area on which the work is done, or beyond the life and direct use of the structure or device produced. These benefits include experimental, demonstration, and public information values. The engineering and custom building cost of a successful experimental machine may be amortized by subsequent quantity production and use. Careful engineering design of a small barn to meet a specific set of conditions and requirements common to many farms may be justified if the design is ultimately used by a number of farmers. Agricultural engineering work of this order may even be successful and worth its cost if the result is only the negative information that some common or proposed practice, design, or project is not feasible under certain combinations of conditions. Farmers and industries supplying materials and equipment for use on farms can thus be spared the cost of determining for themselves that certain ideas are not practicable under their conditions.

This order of engineering work is widely practiced in agricultural engineering. There are combinations of farm conditions sufficiently widespread and persistent to justify the cost of the engineering analysis, research, design, testing, and demonstrations. Unit value of the work is multiplied by the number of units to which it may be applied over an area and period of time to determine whether or not the total value may be expected to justify the cost. Variability of soil, weather, crops, and other conditions, and the characteristic small size of farms and farm structural, mechanical, and electrical equipment makes *range of influence* of results one of the first and most important factors to be considered in determining the justification of most proposed agricultural engineering work.

EDITOR'S NOTE: Other orders of agricultural engineering work will be discussed in subsequent editorials.

Aluminum in Sawdust-Concrete

To the Editor:

OUR attention has been called to a paper and discussion on a new type of concrete which employs sawdust as one of the essential ingredients, published in AGRICULTURAL ENGINEERING for September 1940.

We are wondering if the authors, Messrs. Neubauer and Witzel, have heard of the use of finely divided aluminum powder in concrete to obtain a cellulose material of relatively high strength which has heat insulation properties and other characteristics similar to the sawdust-concrete and which apparently would not be as temperamental in action. I am sending you a reprint put out by the Aerocrete Corporation of America, which contains information on the subject.

It may be that the use of a small amount of aluminum powder with the cement-sawdust mixture would improve the properties of the cement, especially in the case of the red oak and Douglas fir sawdust, since failure here may have been caused by strains set up in the mix as it cured. The use of aluminum powder reacting to form minute cells might offset these bad characteristics and give a product that would have wider utilization. At least it would be well worth trying out.

Should anyone want to conduct experiments in the use of aluminum powder in concrete mixes, we would be glad to cooperate with them to the extent of furnishing samples of the special kind of aluminum powder required for this work. Incidentally, patents on aerated concrete expired some years ago, so that there is no patent situation to be concerned about in development work.

Another suggestion that has been made with respect to the sawdust-concrete is that the surface that has been stated not to be resistant to water, might very well be protected by one or two coats of a good aluminum paint after the forms have been removed and the concrete has had a chance to age.

W. B. ROBERTS

Aluminum Company of America

AGRICULTURAL ENGINEERING

VOLUME 21 NOVEMBER 1940 NUMBER 11

Results of a Corn Husking Mechanism Study

By E. V. Collins, J. M. Trummel, and C. K. Shedd
MEMBER A.S.A.E. JUNIOR A.S.A.E. FELLOW A.S.A.E.

FIELD tests and experience have shown that the husking mechanisms of corn pickers in present use are not completely satisfactory. The two major faults of the mechanisms are the ineffectiveness of husking and the incidental shelling of the corn which is husked.

Results of field picker tests conducted at the Iowa Agricultural Experiment Station in 1931, 1932, and 1933[1]* showed percentages of debris in mechanically picked corn. They ranged from 0.81 to 2.5 per cent by weight, and for the series of tests the average was 1.5 per cent. Assuming that the snapped corn contains 5 per cent husks, which was the average found for snapped corn used in this study, the husking mechanisms were only from 50 to 84 per cent effective under various conditions.

In the same series of field picker tests the per cent of shelled corn was determined. The percentage values ranged from 1.7 to 9.0, with an average of 4.5. Undoubtedly a large part of this was shelled by the husking mechanism.

The mechanical husking problem has been intensified by the trend of increasing corn yields and higher operating speeds of farm machinery. These increases demand a faster husker action in order to husk the corn as rapidly as it is picked. The rate of corn picking varies directly with the corn yield, picker ground speed, and row spacing. For a yield of 100 bu per acre, a ground speed of 3 mph, and a corn row spacing of 42 in, the average rate of corn picking is 2.13 bu per min for a one-row machine.

As listed in the "Tractor Field Book for 1939-40"[2], roll-type husking mechanisms were used exclusively on mechanical corn pickers. The number of husking rolls used ranged from two for a one-row picker to ten for a two-row machine. Roll lengths varied from 31 to 44 in, and the roll diameters varied from 2-7/16 to 3-9/16 in. Nearly all pickers had cast iron husking rolls at that time. One machine used rubber rolls. Such roll types as spiral-ribbed, rasped and steel-pegged, spiral-flute, rubber-and-spiral-flute, and straight-flute are listed. Most pickers used a mechanical device such as an endless belt conveyor to advance the corn ears along the husking rolls. Some pickers used gravity feeds with retarder plates to regulate the movement of ears along the rolls.

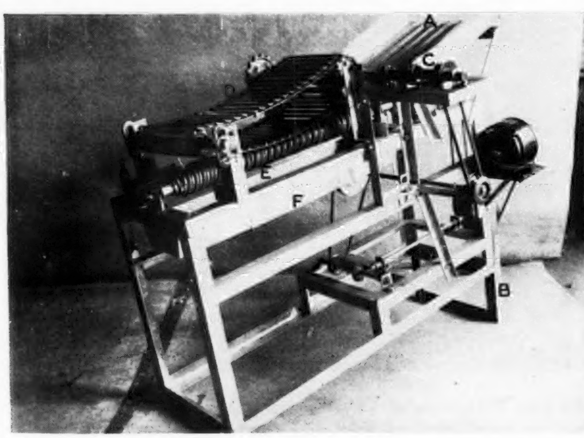
In 1931 the South Dakota State College published the results of an investigation[3] on husking corn with a stationary husker.

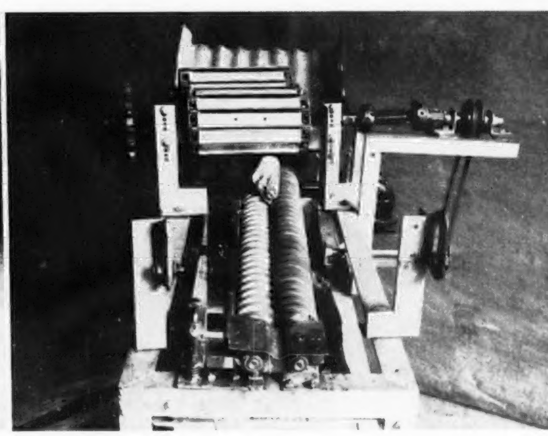
The present study was conducted at the Iowa Agricultural Experiment Station in 1939 and deals with investigations of several roll-type husking mechanisms. The experiment involved laboratory tests to determine the performance characteristics of some mechanisms. The characteristics determined were the husking effectiveness and the amount of corn shelled. An effort was also made to determine the effects of various speeds, adjustments, and corn conditions on the performance of the mechanisms.

Apparatus Used. A machine for testing husking mecha-

Journal Paper No. J-787 of the Iowa Agricultural Experiment Station, Project 394. Authors: Respectively, research professor of agricultural engineering, Iowa Agricultural Experiment Station; research fellow in agricultural engineering, Iowa State College, and agricultural engineer, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture.

*Superscript figures refer to literature cited at the end of this paper.





TWO VIEWS OF A MACHINE FOR TESTING CORN HUSKING MECHANISMS

Fig. 1 (left) The testing machine tilted at 10 deg with the horizontal; (a) unhusked ear hopper, (b) tilting frame, (c) ear forwarder drive, (d) endless-belt ear forwarder, (e) husking roll, (f) shelled corn and husk collector pan. Fig. 2 (right) Roll combination CI in the testing machine. This combination removed an average of 88.0 per cent of the husks and shelled 1.66 per cent of the corn husked. Spiral rolls help advance the corn ear along the husking roll. The endless-belt ear forwarder set at a horizontal angle with the roll axis rotates the corn ears, thereby increasing husking effectiveness

nisms was constructed and is illustrated in Fig. 1. This machine consisted fundamentally of a frame to support the mechanisms and a system of drives to operate the mechanisms. Variable-speed V-belt drives for the husking rolls and ear forwarder were used. An adjustment for varying the slope of the husking rolls and an adjustment for varying the angle between the ear forwarder and the roll axis were provided. Scales, balances, and hand sheller constituted the other equipment used.

Mechanisms Tested. The rolls used in the combinations tested are listed and described in Table 1. All husking rolls were built in sections one foot long and assembled on a 1⅝-in diameter, keyed, steel shaft. The rolls fit freely on the shafts, thus permitting a rapid and simple change of roll combinations. Assembled rolls 36 in in length were used in all except the roll-length tests. An endless-belt ear forwarder was used.

Test Procedure. In running the tests, a twenty-ear sample of snapped corn was used. This corn was snapped by hand and averaged 5 per cent husks by weight. It was similar to the corn delivered to the husking bed of a corn picker. The samples were not especially selected but were taken as they came from storage in order to get an average sample. Three test runs were made for each combination of operating conditions tested. This made possible a statistical analysis of the data.

The weight of husks not removed and the weight of husks removed were recorded for each test run. The weight of corn shelled by the mechanisms and the total shelled weight of the twenty-ear sample were also recorded. Corn husk samples were taken and moisture content determined.

TABLE 1. DESCRIPTION OF ROLLS USED IN VARIOUS COMBINATIONS

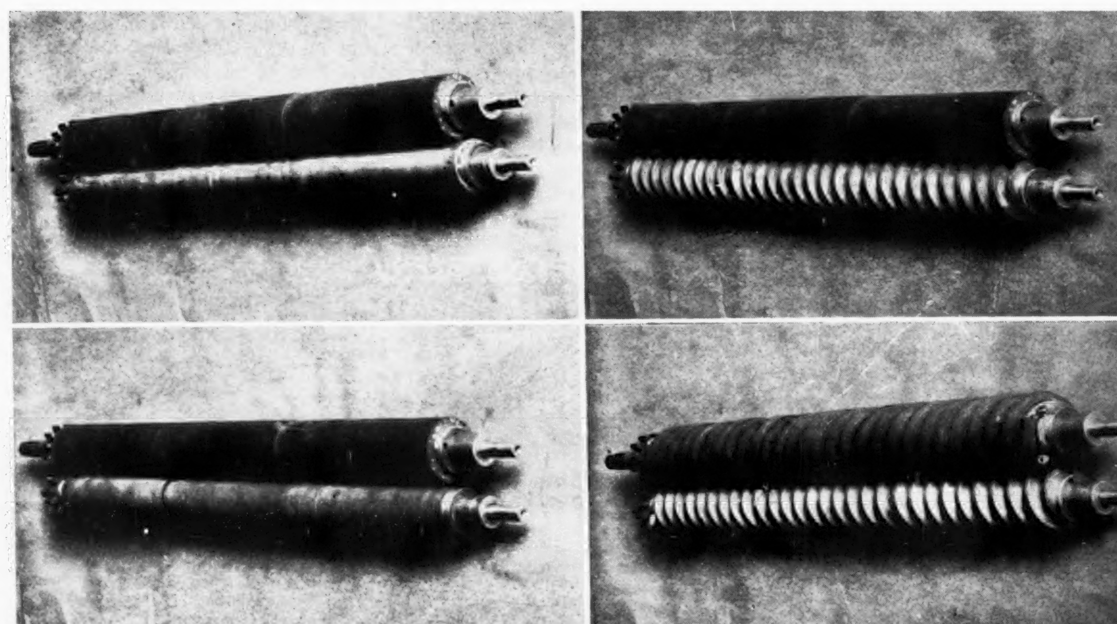
Roll symbol	Diameter, in	Description
A	2¾	Smooth steel roll
B	3	Left-hand spiral roll. Cast iron. Double thread, 2½-in lead
C	3	Right-hand spiral roll. Cast iron. Double thread, 2½-in lead
D	3¼	Smooth, fairly soft rubber roll
E	2¾	Smooth, fairly soft rubber roll
F	3¼	Smooth, firm rubber roll
G	3⅛	Smooth wood roll
H	3⅞	Left-hand spiral roll wrapped with ⅞-in diameter rubber cushion tire stock
I	3⅜	Left-hand spiral roll wrapped with ⅝-in diameter rubber cushion tire stock

The husking effectiveness of a mechanism was expressed as the percentage of husks removed. These values were based on the amount of husks originally on the sample. The extent of corn shelling was expressed as the percentage of the total shelled sample weight.

Tests were run on several mechanisms at various speeds, adjustments, and corn conditions. The results are listed in Table 2.

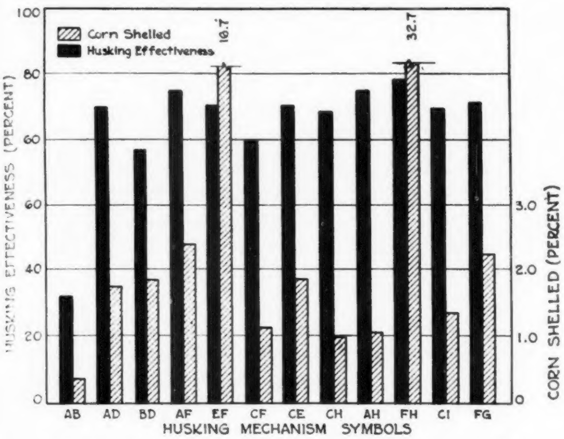
DISCUSSION OF RESULTS

Roll Speed Effects. Analysis of the data gave statistically significant differences in husking effectiveness at the lower speeds, that is, at 105, 200, and 250 rpm. No significant differences in shelling due to different roll speeds were found for roll combination AD, but in the case of combination BD, the shelling decreased with increasing roll



CORN HUSKING ROLL COMBINATIONS USED IN IOWA TESTS

Fig. 3 (upper left) Roll combination AD which gave an average husking effectiveness value of 92.9 per cent and an average shelled corn value of 1.71 per cent. This combination uses a smooth firm rubber roll and a smooth steel roll. Fig. 4 (upper right) Roll combination CF. This combination gave an average husking effectiveness of 80.0 per cent and shelled 1.13 per cent of the corn husked. A smooth rubber roll and a cast-iron right-hand spiral roll. Fig. 5 (lower left) Roll combination EF. This combination removed 90.8 per cent of the husks and shelled 16.7 per cent of the corn. These two rubber rolls used in combination shelled excessive amounts of corn. Fig. 6 (lower right) Roll combination CH which removed 88.7 per cent of the husks and shelled 1.0 per cent of the corn. In general, spiral rolls shell less corn than smooth cylindrical rolls with the same surface. This combination is of two spiral rolls, one of which was wrapped with ⅞-in diameter rubber cushion tire stock



GRAPHICAL COMPARISON OF ALL MECHANISMS TESTED

Fig. 7 The roll combination with the highest husking effectiveness shelled a prohibitive amount of corn. The combination shelling the least corn was also the least effective husker. Roll combination AH, which is composed of a smooth steel roll and a rubber wrapped spiral roll, gave the best results with a husking effectiveness of 94.9 per cent and with a shelled corn value of 1.16 per cent. Combinations AB, CF, CH, and CI gave shelled corn values below the average; each of them used one or more spiral rolls in combination, indicating that spiral rolls help decrease corn shelling

speeds. The decrease might be explained by the spiral roll in combination BD. Spiral rolls help advance the corn ears along the rolls and help prevent stalling of the ears on the rolls, thus decreasing the opportunity for the corn ear to be shelled.

Ear Forwarder Speed Effects. The differences in husking effectiveness and corn shelled between the test runs at forwarder speed of 72 ft per min and the runs at 80 ft per min were found significant. The husking effectiveness increased and the shelling decreased with the increase in forwarder speed from 72 to 80 ft per min. No statistically significant differences were found in the range from 80 to 127 ft per min, although the value of husking effectiveness obtained at the 127 ft per min forwarder speed was markedly lower. However, the variance in the data for that test was great enough to show that the difference might have been due to chance.

Husking Roll Slope Effects. No statistically significant differences in husking effectiveness or shelling were found for different slopes in the range from 0 to 20 deg. This appears reasonable as the changes in the forces acting on the ear due to changes in angle with the horizontal are small in comparison with the total forces acting on the ear.

Effect of Ear Forwarder Angle. Two ear forwarder angles were used, zero and 8 deg. Comparison tests were run on roll combinations AF, CH, and CI. A highly significant difference in husking effectiveness due to the two different angles was found for combination AF. The average increase was from 44.1 per cent for the zero angle to 95.1 per cent for the 8-deg angle. This indicates that the ear rotation obtained by angular setting is important in mechanical husking with a roll-type mechanism. Also, in the case of combination CI, the husking effectiveness increased significantly with the 8-deg angle as compared to the zero angle.

Effect of Direction of Ear During Husking. Tests in which all ears were husked tip first and others in which all ears were husked butt first were run on combination AD and CH. Although the samples husked tip first gave greater values of husking effectiveness for both combina-

TABLE 2. VALUES FOR HUSKING EFFECTIVENESS AND CORN SHELLED WITH SEVERAL ROLL COMBINATIONS
(Combinations Are Indicated by Roll Symbols Used in Table 1)

Roll combination	Factor variation	Variable value	Per cent husking effectiveness	Per cent corn shelled
AD	Roll, rpm	200	80	2.93
		255	97.3	3.04
		300	91.5	1.54
		350	97.7	1.40
		400	94.0	3.80
		450	95.0	4.20
		500	90.0	1.59
		545	100.0	1.62
		600	97.0	2.20
		645	94.5	1.47
		700	92.7	3.86
BD	Roll, rpm	105	68.5	4.17
		200	76.9	4.04
		300	81.7	1.70
		400	84.6	0.64
		500	77.4	2.01
		600	74.9	0.70
		700	73.7	0.53
AD	Forwarder, ft/min	72	90.0	2.09
		80	94.7	1.04
		86	93.9	1.05
		108	98.3	1.44
		127	85.5	0.63
AD	Roll slope, deg	0	94.2	0.81
		5	85.5	0.63
		10	86.8	0.96
		15	91.0	1.45
		20	90.3	0.92
CE	Roll slope, deg	0	92.5	3.39
		5	91.2	1.35
		10	91.8	1.24
		15	88.8	1.20
		20	88.7	2.00
AF	Forwarder angle, deg	0	44.1	0.40
		8	95.1	2.36
CH	Forwarder angle, deg	0	73.9	1.35
		8	87.9	1.97
CI	Forwarder angle, deg	0	85.2	1.90
		8	92.0	0.75
AD	Ear direction	Tip 1st	96.9	1.35
		Butt 1st	92.5	1.23
CH	Ear direction	Tip 1st	91.9	0.91
		Butt 1st	83.4	1.37
AB	Husk moisture, per cent	10	16.7	0.33
		60	32.9	0.07
BD	Husk moisture, per cent	11	68.5	0.83
		60	83.2	4.24
AF	Husk moisture, per cent	10	44.1	0.47
		42	56.2	0.72
EF	Husk moisture, per cent	8	86.0	18.5
		15	92.6	11.2
		42	94.3	11.8
		45	90.3	5.32
CH	Husk moisture, per cent	10	92.0	0.75
		50	86.2	0.95
AD	Roll length, in	12	73.1	1.09
		24	96.7	1.25
		26	100.0	2.75
AB	Averages		30.9	0.36
AD			92.9	1.71
BD			77.6	1.82
AF			95.1	2.36
EF			90.8	16.7
CF			80.0	1.13
CE			90.8	1.84
CH			88.7	1.00
AH			94.9	1.16
FH			98.3	32.7
CI			88.0	1.66
FG			91.0	2.23

NOTE: All factors except the one indicated as varied, were held constant for each series of runs. All values are an average of three or more test runs. All moisture results are calculated on wet basis.

tions, only the difference for combination CH proved statistically significant. For combination CH the shelling was greater for the samples husked butt first. The weight of evidence is in favor of husking the ears tip first.

Effect of Husk Moisture Content. The average values of husking effectiveness increased with the increase of moisture content of the husks in all roll combinations tested, except in the case of combination CH.

Some difficulty was experienced when the rubber-surfaced rolls became wet. Although the rubber rolls took hold of the wet husks, they were rather ineffective in pulling wet husks off the ears. Two factors contributing to this difficulty were the increase in husk toughness with the increase in its moisture content, and the reduction of the roll-surface friction coefficient due to the lubricating action of water and dirt.

Effect of Roll Length. Husking effectiveness and corn shelled were determined for three lengths of roll combination AD. The 12-in roll removed most of the corn husks and shelled less corn than the 24 or 36-in roll. After most of the husks were removed in the first section, the shelling increased rapidly in the second and third foot sections. Upon increasing the roll length from 24 to 36 in, the husking effectiveness increased only 3.3 per cent and shelling increased 1.5 per cent. For this particular roll combination (AD), a 24-in roll is the most desirable length. The more effective husking rolls should be shorter as most of the corn shelling is done after the husks are removed.

Comparison of the Mechanisms Tested. The average values of the performance characteristics of all the mechanisms tested are listed in the latter part of Table 2. The mechanism with the greatest husking effectiveness also shelled a prohibitive amount of corn. Roll combinations AD, CH, and AH gave some of the best results with husking effectiveness values of 92.9, 88.7, and 94.9 per cent and shelled corn values of 1.71, 1.00, and 1.16 per cent, respectively. Combination AD is a smooth rubber roll and a smooth steel roll combination. Combination CH is a spiral roll combination with one of the spiral rolls wrapped with 7/8-in (diameter) rubber. Combination AH is a rubber-wrapped spiral roll and a smooth steel roll combination. The combination using one or more spiral rolls, in general, gave less shelled corn than a cylindrical roll of the same surface material.

CONCLUSIONS

1 Rotation of corn ears is important for effective husking. The use of an ear forwarder set at an angle with the roll axis is a satisfactory method of obtaining ear rotation.

2 A spiral type husking roll has an advantage over smooth cylindrical rolls in that the spiral roll will help advance the ear along the roll if properly designed and constructed.

3 Corn may be husked more effectively by roll-type mechanisms when the ears are all husked tip first.

4 More effective husking and less shelling of corn is done by the first half of a husking roll. Less husking and more shelling are done on the second half of the roll. Most of the corn shelling is done after the husks are removed from the ears. The more effective a husking roll, the shorter it should be.

5 For the types of husking mechanisms tested, the slope of the husking rolls, within the range of zero to 20 deg, has no effect on the husking characteristics of the mechanism.

6 Roll speeds in the range from 250 to 700 rpm have no significant effects on the husking effectiveness of a roll mechanism. Roll speeds below 200 rpm reduce husking effectiveness.

7 The speed of a smooth cylindrical roll has no effect on corn shelling. The corn shelling effectiveness of a smooth spiral roll decreases with increased speed.

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Drying Hybrid Seed Corn

FULLY 77 per cent of the Illinois corn acreage, or more than six million acres, was planted with hybrid seed in 1940. The production of sufficient seed corn to plant this large acreage has involved the installation and operation of extensive drying equipment.

Seed corn production has become a large commercial industry in Illinois. The proper operation of the drying plants used in processing this seed is of vital importance not only to producers but also to every farmer who buys and uses the seed.

Drying tests of hybrid seed corn were made over a period of four years in order to study the germination and yield of seed dried under different conditions. This preliminary report has been prepared so that some of the data may be available for use during the present drying season.

The hybrids studied, when dried under the same conditions, did not show an appreciable difference in rate of drying, in germination, or in yield of grain. The number of hybrids studied was too small to draw general conclusions.

Except in two cases, a temperature of 120 F did not adversely affect viability and yield. In addition no evidence was found which would indicate that better results can be secured by reducing the drying temperature below the established value of 110 F.

The humidity of the drying air becomes of increasing importance as the temperature of the air and the moisture content of the corn are increased.

Length of drying time becomes of increasing importance as unfavorable conditions are introduced.

Corn of a high moisture content is much more susceptible to drying injury than corn having a low moisture content.

Air velocity is an important factor because high velocities may cause injury due to too rapid removal of moisture and consequent mechanical injury to the internal structure of the seed, whereas low velocities may cause injury due to too slow removal of the moisture, accompanied by high kernel temperatures.

Many kernels which blistered slightly in the drying studies germinated and grew satisfactorily, a fact which shows that the mere presence of blisters does not indicate poor seed, although they may make the corn more susceptible to certain forms of damage.

Experiments other than those reported here have shown that very slow drying is associated with a much higher percentage of seedling infection than is either rapid or moderate drying.

The rate of drying and the factors affecting that rate may be particularly important during unfavorable drying years.—*From an Illinois Agricultural Extension Mimeograph on the subject, by R. H. Reed and Geo. H. Dungan.*

A Graphic Light Meter

By Kenneth Post and Maurice W. Nixon
MEMBER A.S.A.E.

IT became necessary to obtain a record of the normal length of day in a research project dealing with the use of artificial light and effects of day length upon flowering of plants. To obtain these data, an apparatus was designed to measure low light intensity (from 1/2 to 100 foot-candles) and the total quantity of light in terms of foot-candle hours (Fig. 1 and Diagram 1).

The photronic cells are mounted on the roof of the head-house of a greenhouse, where they would not be affected by surrounding objects. The cells were covered with double-walled pyrex glass domes containing a mixture of 40 per cent water and 60 per cent glycerine in the wall. The purpose of this was to filter much of the heat energy from the light rays to prevent the cells from overheating, and to intercept light rays from all directions above the horizontal. This was accomplished by sand-blasting the inside of the cover dome, thus producing an effective secondary light source on the inside of the dome, to which the photronic cells responded. The pinch cocks at the tops of the domes were closed after filling. The solution required changing about twice each year because of a slight discoloration.

The readings obtained from the instrument were low because of the absorption and reflection of light by the filter dome. A correction factor must be applied to obtain the true foot-candles and foot-candle hours.

The charts (Fig. 2) are typical of those obtained from the recorder. The advantage of the relay in shifting the recorder from the 0 - 100 foot-candle scale to the 0 - 10,000 scale is apparent. Intensities below 100 foot-candles could not be recorded nor accurately read were it not for this automatic range-selecting arrangement.

The recorder chart passed the pen at the rate of one inch per hour. The time spaces on the chart being 1/2 in apart represent, therefore, 1/2 hr. Chart 1 (Fig. 2) shows that it was sufficiently light to operate the pen on the 0 - 100 foot-candle scale at 4 a.m. A light intensity of 100 foot-candles was reached at 4:56 a.m., and the sensitive relay shifted the recorder pen to the 10,000 foot-candle scale. The intensity of light increased, reaching the high point about 12:15 p.m., then decreased to less than 100 foot-candles at 7:32 p.m., when the meter was shifted back to the 0 - 100 foot-candle scale. It was dark at 8:23 p.m. This gave a day length of 16 hr and 23 min above 1/2 foot-candle and a total of 14 hr and 36 min above 100 foot-candles of light. Likewise the exposure or length of day above any other desired intensity could be readily determined. The solar day or time from sunrise to sunset was 15 hr and 4 min.

A celluloid scale divided in sixtieths of an inch was used to measure the length of day in hours and minutes.

By measuring the length of any daily chart, the day length in hours and minutes of light above any given intensity can be determined. Total day length in terms of hours of light above 1/2 foot-candle and hours of light above 100 foot-candles are thus determined and plotted as ordinates above a calendar scale as in Figs. 3 and 4, respectively. These charts represent the data taken through one calendar year, and the spaces indicate periods when no records were taken or the record was otherwise of no value. One might expect that over a period of time the maximum value of the ordinates would produce a smooth curve. In other words, if the records of several years were superimposed on the same chart, a smooth curve would eventually result. The daily variation in day length in both charts was due to variations in weather conditions.

Fig. 4 indicates the hours from sunrise to sunset as reported by the U. S. Weather Bureau. It will be noted that for any given day the period from sunrise to sunset is always longer than the period of light intensity above 100 foot-candles and shorter than the period above 1/2 foot-candle. The light intensity was never above 100 foot-candles at sunrise and always fell below 100 foot-candles before sundown. There was considerable variation in the

The research reported in this paper was made possible through funds supplied by the Empire State Gas and Electric Association for the purchase of equipment to study the effects of increasing the length of day by the use of electric lights of varying types and intensities upon the growth and time of flowering of greenhouse plants. The project was started in 1936. The authors are, respectively, associate professor of floriculture and ornamental horticulture, Cornell University, and rural service engineer, Empire State Gas and Electric Association.

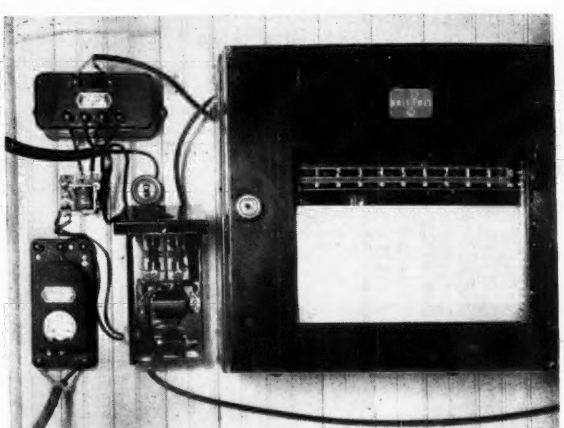


FIG. 1 RECORDING EQUIPMENT FOR LIGHT INTENSITY MEASUREMENTS

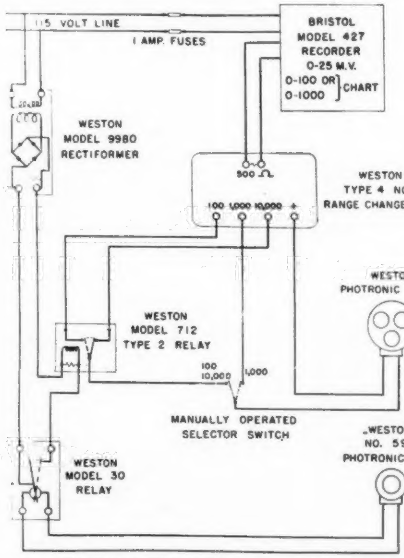


DIAGRAM 1 WIRING FOR GRAPHIC LIGHT METER

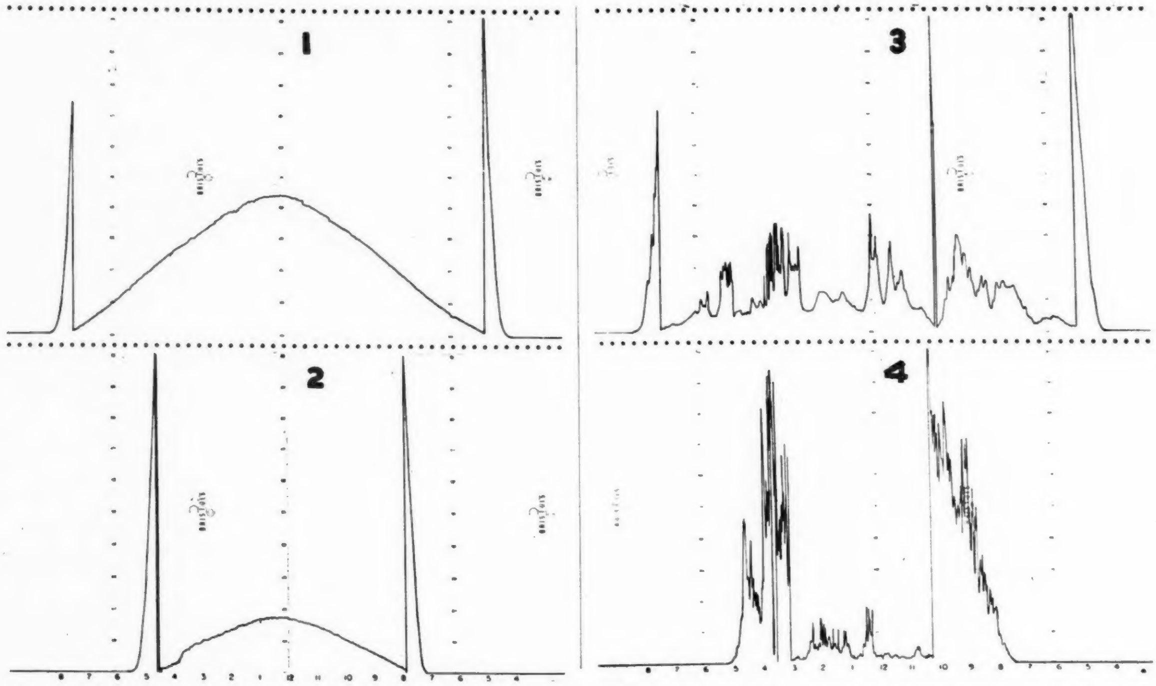


Fig. 2 Charts from the graphic light meter. The values indicated must be multiplied by a constant to obtain true foot-candle values. From one to four they represent charts for (1) a clear summer day (July 3, 1939), (2) a clear winter day (January 20, 1939), (3) a cloudy summer day (July 7, 1939), and (4) a cloudy winter day (January 11, 1939)

number of hours above 100 foot-candles of light each day.

These charts indicate that the day length which may be expected to affect the photoperiodicity of plants is greater than the hours from sunrise to sunset. The day length varies somewhat from day to day, depending upon atmospheric conditions, and it may remain nearly the same for several days, then change quite radically to a different value. This doubtless affects the bud formation of plants which depend upon day length for the response.

The area below a daily light intensity curve is a measure of the total quantity of light impinging on the photoelectric cell in the time interval involved. This area was integrated for each day and the resulting foot-candle hours were plotted as ordinates above a calendar scale as in Fig. 5, which indicates the foot-candle hours for each day throughout one year. The extreme variation in the daily values are due to variations in cloudiness.

The planimeter calibrated to read hundredths of an inch, thus reading directly in foot-candle hours, was used to measure the area covered by the pen.

SUMMARY

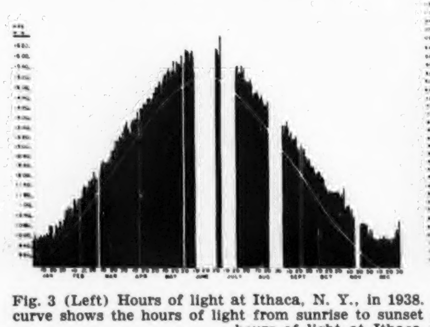
1 A graphic light meter was assembled, using standard apparatus wherever possible.

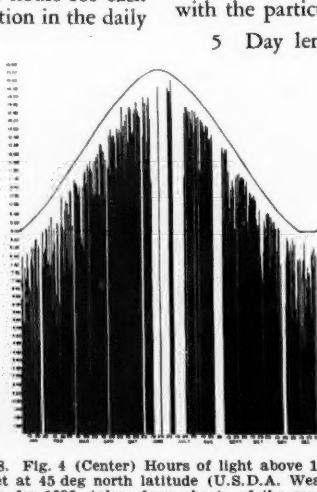
2 The recorder has been in operation at Ithaca, New York, since March 1937, with the exception of a few days lost in making adjustments.

3 The recorder operated at light intensities below one foot-candle, and followed closely the reading of a standard meter at low intensities.

4 The recorder operated at a light intensity below that necessary to operate the pyrheliometer. It did not follow the pyrheliometer at high light intensities, probably because the meter was not calibrated and adjusted for use with the particular filter domes used.

5 Day length in terms of hours of light above any given light intensity, and total foot-candle hours of light were obtained from the charts by the use of a suitable scale and a planimeter.





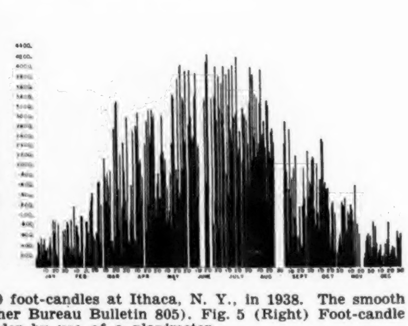


Fig. 3 (Left) Hours of light at Ithaca, N. Y., in 1938. Fig. 4 (Center) Hours of light above 100 foot-candles at Ithaca, N. Y., in 1938. The smooth curve shows the hours of light from sunrise to sunset at 45 deg north latitude (U.S.D.A. Weather Bureau Bulletin 805). Fig. 5 (Right) Foot-candle hours of light at Ithaca for 1938, taken from charts of the recorder by use of a planimeter

Recent Studies in Raindrops and Erosion

By J. Otis Laws

THE relation of raindrop size to erosion and infiltration has recently been made the subject of a series of studies carried on by the U. S. Soil Conservation Service as a part of a general program of investigation into the mechanics of the water-erosion process. These studies are believed to be of general interest not only because of their novelty but also because of the new light they throw upon agricultural problems.

To study raindrop sizes sounds like the height of pedantry, but these researches have already found application. As a result of these studies, artificial rainfall applicators, which are rapidly gaining favor as instruments for making certain hydrologic measurements, are now being designed to produce sprays of large drops. The Flood Survey has recently adopted this type of apparatus as standard equipment.

Because of the newness of this approach to the soil conservation problem, several subsidiary investigations had to be made. These mutually dependent studies, which are both interesting in themselves and essential to a better understanding of the mechanical processes involved, will be reviewed briefly.

The first four of these studies were carried out at the hydraulic laboratory of the National Bureau of Standards as a part of the research program of the hydrologic division of the Soil Conservation Service. These studies were planned by H. L. Cook, head of the hydraulic section, and were supervised by D. A. Parsons, project leader. The fifth study was undertaken at the suggestion of Dr. H. H. Bennett, chief of the Soil Conservation Service, and was carried out in the laboratories of the Massachusetts Institute of Technology by Edgerton, Germeshausen, and Grier, consulting photographers.

Comparison of Artificial Sprays. In a series of thirteen tests, five different rain applicators were compared on a basis of the amount of erosion and infiltration that resulted when they were applied to a tray of soil. These tests furnished the starting point of the subsequent investigations. It was hoped to ascertain whether the type of spray used had any appreciable effect upon the erosion and infiltration. A fresh tray of soil was prepared for each test, and an endeavor was made to hold constant all variables except the drop size of the spray. The drop sizes obtained with the five different applicators ranged from about 1 to 5 millimeters in diameter.

It was found that as the drop size increased, the infiltration rate decreased by as much as 70 per cent, and that the erosion losses, which were measured in terms of the concentration of the soil in the runoff water, *increased* by as much as 1200 per cent. In view of these results it can no longer be doubted that the drop size of rainfall has an important effect on erosion and runoff. These data also proved that artificial rainfall apparatus must actually simulate rainfall, so far as drop size is concerned.

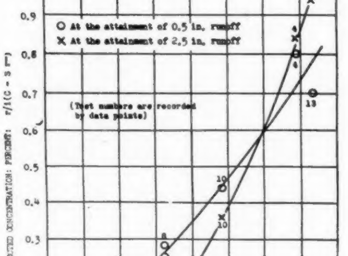
A question arose as to what drop size such apparatus should produce. To answer this question it was necessary, among other things, to know how the drop sizes of the sprays compared with those of natural rains.

Measurement of Drop Size. At first glance the measurement of the drop sizes in a spray composed of hundreds of drops would seem to be an insuperable task. However, fairly complete and accurate measurements of raindrop sizes were made as early as 1890 by Wiesner[1]*, a German meteorologist. His method involved exposing a sheet of absorbent paper to the rain for a few seconds and then measuring the size of the spots formed by the drops. With the help of a relation between spot diameter and drop diameter predetermined under controlled conditions, he was able to arrive at the size of the raindrops. W. A. Bentley[2], an American investigator, exposed pans of flour to the rain and studied the size of the pellets thus formed.

Bentley's technique was used in the present measurements, although it was modified and refined. The flour used was carefully calibrated by determining the relation between drop weight and dry pellet weight for drops of various sizes after various heights of fall. Then, when a

Presented before the Soil and Water Conservation Division at the annual meeting of the A.S.A.E. at State College, Pa., June 18, 1940. The author is assistant soil conservationist, hydrologic division, Soil Conservation Service, U. S. Department of Agriculture.

*Superscript figures refer to bibliography at the end of this paper.



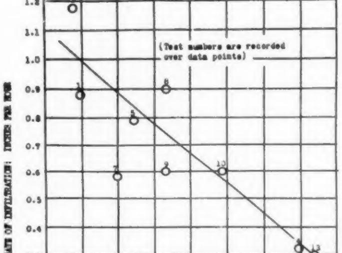


Fig. 1 (Left) Relation of soil concentration, corrected for intensity differences, to the E/A index of rain erosivity at the attainment of 0.5 and 2.5 in of runoff. Fig. 2 (Right) Variation in infiltration rate with E/A index of rain erosivity at the 45th minute after the beginning of the rains

sample of spray was taken, the pellets were dried in a uniform manner, separated from the flour by screening, and sorted into size groups by simply putting them through a set of standard sieves. The weight of the average pellet on any sieve was then accurately determined by weighing the catch and counting the number of pellets. From the weight of the average pellet the weight of the average drop was calculated by the predetermined relationship.

In this way a complete picture was obtained of the size distribution in the rain. In effect the raindrops had been subjected to a sieve analysis.

Complete measurements were made of drop sizes in the five different sprays used in the comparative tests. A systematic sampling of natural rain was also begun and continued for a period of a year to get more complete measurements of the size of raindrops. In this study simultaneous measurements were made of intensity to see whether this factor could be correlated with drop size.

Measurements made of the artificial sprays showed that the drop sizes produced by all of the devices in use at the time were smaller than ordinarily occurred in hard natural rain, as measured in Washington, D. C. The comparison of natural and artificial rains on the basis of drop size alone, however, is not warranted, because the drops produced by artificial means fall at lower velocities than do raindrops. It was necessary, therefore, to determine what these velocities were.

Measurement of Drop Velocity. A search of the literature revealed that very few measurements had ever been made of the velocities of falling water drops. A few measurements by German investigators were found, but these applied only to raindrops and were of no help in ascertaining the velocities of spray drops falling from limited heights. It was therefore necessary to develop equipment and make these measurements.

A photographic apparatus was devised for this purpose, and measurements were made of velocities of water drops ranging in diameter from 1.1 to 6.1 mm (millimeters), after heights of fall ranging from 0.5 to 20 meters. Measurements were also made of the velocities of natural raindrops to check the work of the German investigators.

Surprisingly enough, the values obtained for the velocities of the larger drops were 15 per cent higher than those recorded by the Germans. For example, the velocity found by Lenard[3] for a 6-mm drop was 7.9 meters per second, whereas our measurements showed a velocity of 9.3 meters per second. Having thoroughly checked our own measurements, we are forced to the conclusion that large experimental errors must have been present in the measurements of these earlier investigators whose values have been accepted as correct for forty years.

As a result of these measurements it was possible to prepare curves showing the relation between drop size and velocity after various heights of fall. These curves will be published elsewhere.

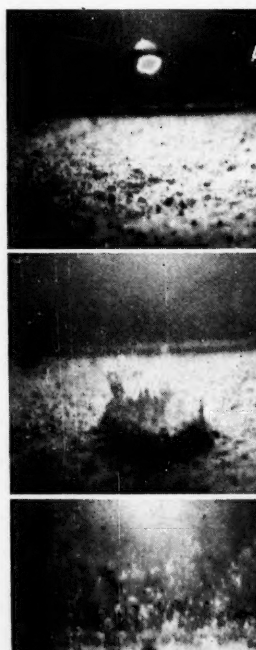
These measurements, together with the measurements of drop size, made it possible to give a complete description of the drop characteristics of the sprays used in the comparative tests, in which a meticulous record had been kept of the soil and water losses. It was now possible to study the precise nature of the relation between the drop characteristics of a rain and the resulting erosion and infiltration.

Correlation of Drop Characteristics with Erosion and Infiltration. Any given rain is composed of a bewildering mixture of drops of different sizes falling at different velocities. Data describing the drop characteristics are useless until formulated in some manner. The question is how should these data be treated in order to obtain some number that is quantitatively descriptive of the erosion-producing potentialities of the rain.

The key to a possible solution of this problem lies in viewing the phenomenon of erosion as a purely mechanical process. When soil is moved, mechanical work is done. What is the source of the energy for this work? Certainly part of it is derived from the kinetic energy of the falling raindrops. This immediately suggests that there may be some correlation between the energy expended by the rain and the resulting soil losses.

When the size and velocity of the drops are known, the energy can be computed because the kinetic energy of a drop is one-half its mass times its velocity squared. To compute the energy in a rain one has only to add the energies of the individual drops composing it.

By pursuing this lead, several formulations were found that reduced the devious drop data of the sprays to single index numbers that bore fairly consistent relations to the soil concentrations observed in the comparative tests. These indices were also found to bear an inverse relationship to the infiltration rate. The correlations can be examined in Figs. 1 and 2.



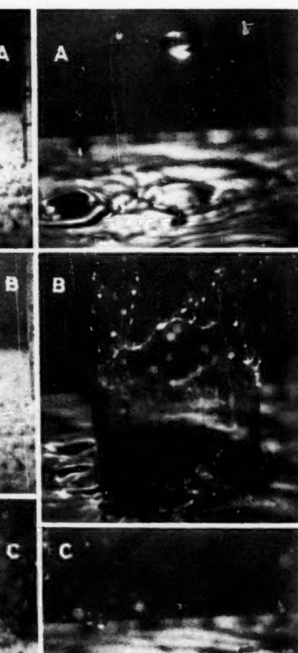


Fig. 3 (Left) Plate 1. A large drop striking loose, powdery soil resembles, in slow motion, the blast of an air bomb. (A) Just before striking. Notice the absence of any tail on the drop. (B) Just after striking. (C) Four-hundredths of a second later; the air is filled with flying soil particles. Fig. 4 (Right) Plate 2. When the soil is covered with a film of water, the principal effect of drop impact is to create turbulence. (A) Just before striking. Notice the absence of any tail on the drop. (B) Just after striking; the soil surface is discernible through the transparent walls of the liquid cylinder. (C) Turbulent wake left by the collapse of the walls of the cylinder. Photography by Edgerton, Germeshausen, and Grier

In addition to the E/A (Energy/area) index, there appear on these figures values representing the "equivalent raindrop diameter." This value was derived from the E/A index and the velocities of falling raindrops. In examining these figures it is important to realize that these values depend solely upon the size and velocity of the drops composing the spray and that they increase with increasing drop size or increasing drop velocity.

Fig. 1 shows the relation between the soil concentration and the E/A index of rain erosivity. The observed concentration has been corrected for the erosion attributable to the scouring of runoff water. The manner of making this correction is outside the scope of this paper.

The comparisons have been made at two different stages of the runoff—at the attainment of 0.5 in of runoff and at the attainment of 2.5 in of runoff.

It will be observed that as the E/A index increases, the soil concentration increases; that is to say, as the size or velocity of the drops increases, the concentration of the soil in the runoff increases.

The magnitude of the concentration is seen to depend upon the time at which comparisons are made, indicating that the erodibility of the soil surface is changing during the test. The crossing of the curves indicates that the change in the erodibility of the plot is sometimes in a direction to increase the amount of erosion as the test progresses.

Fig. 2 shows the relationship of both the E/A index and the equivalent raindrop size to the infiltration rate at the 45th minute after the beginning of the rains. The scatter of the data points is wide, but the trend is unmistakably toward lower infiltration rates with increasing values of the E/A index, that is, with increasing drop size or drop velocity. Evidently the drop characteristics of a spray affect the rate of infiltration that will occur, and for a given height of fall, the larger the drop, the lower the infiltration rate.

Examination of Drop Impacts in Slow Motion. In speculating upon the mechanical action of raindrops striking soil, we are handicapped by not being able to see what happens; the whole complex occurrence is over in the twinkling of an eye. It was suggested by Dr. Bennett that the services of Edgerton, Germeshausen, and Grier[4], specialists in "stop-action" and high-speed photography, be brought to bear upon this problem. Accordingly it was arranged to have these men photograph waterdrops striking soil in a number of different conditions.

A few details of the technique used in obtaining these photographs will doubtless be of interest to camera users.

The Edgerton high-speed motion picture camera has no shutter; it is simply a mechanism designed to move 35-mm film past a lens at a high rate of speed. The motion of the film is synchronized with a gas discharge lamp, which is the salient feature of the apparatus. This lamp gives off extremely brief pulses of light as frequently as 2000 times a second; the duration of the flashes is about 1/200,000 second. These pulses of light are necessarily exceedingly brilliant. The exposures are made by the intermittent illumination given to the subject by the lamp and the exposures are so brief that no blurring of the image due to the motion of the film during exposure is perceptible.

With this equipment, a photographic study was made of the action of drops striking three different soils—Kaolin clay, Cecil fine sandy loam, and Vernon very fine sandy clay loam. Each soil was studied under three different conditions: air dry, wet, and flooded. Selections of photographs taken from two of these series are reproduced here (Figs. 3 and 4).

These photographs show that, unlike other single frames from a high-speed motion picture film, the individual pictures are not blurred due to the movement of the object. They are therefore admirably adapted to a study of successive phases of a splash.

Significance and Application. The significance of the results of these studies has probably not yet been fully realized. Several new concepts have been gained that help in understanding the processes involved in erosion. For example, the explanation of the variation in erosion in different geographic regions may lie in a difference in the raindrop sizes predominating in these regions.

One important application of the findings has already been pointed out. That is in the design of artificial rainfall apparatus. Applications are not limited, however, to experiments conducted under simulated rain. It is quite possible that, in carefully controlled experiments conducted under natural rain, it may be found necessary to take account of the drop sizes occurring in different storms.

Probably the most significant result of these studies is that they demonstrate that rain intensity and duration records by themselves do not constitute an adequate description of rain. To adequately describe rain so far as erosion and infiltration are concerned, it is necessary in addition to know the size and velocity of its drops. The relative significance of the drop characteristics depends upon a multitude of factors, such as cover, slope, and soil type, and has yet to be evaluated.

AUTHOR'S NOTE: More detailed descriptions of the several phases of the work are being prepared for publication in the near future.

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Industrial Research

MAINLY, management has accepted science as something that has come to stay. Scarcely an industrialist of importance remains who has not either accepted research as an industrial function, or been forced to admit that his research-minded competitors are spraying him with red ink.

Most spectacularly, of course, research has evolved new products. It has improved old products.

For all manner of products, research has found new uses, and broader markets.

By eliminating waste, by improving the quality of materials, by improving manufacturing processes, research has cut costs.

By spreading among large numbers of persons the kinds of information that used to be called guild secrets, research has enabled whole industries to strengthen themselves.

In a changing world, in a changing America, research has kept managerial policies abreast of the times—or ahead.

Finally, and perhaps most importantly, the mere association with research—research's mere proximity—has altered managerial thinking. More and more widely, management has come to realize that a closed door keeps more out than it keeps in.—*From "Industrial Research in Your Own Business," by Lewis W. Waters, in "Dun's Review," September 1940, and reprinted by Arthur D. Little, Inc.*

Lilliputian Interlocking Steel Piling an Aid in Terrace Outlet Structures

By F. Edward Crosby

THE failure of an outlet channel for a terrace system made necessary the maintenance work which resulted in the rather unique use of "small bore" sheet metal piling.

An outlet section protected by a dense sod obtained by direct seeding was constructed on an 8 per cent slope of Melrose and Sudbury fine sandy loam with utmost success—until the following spring thaws. It was found that this sandy loam, which is two to three feet deep over compact noncalcareous clays, was frozen to only two-thirds its depth and that it thawed in spots allowing the melting snows to percolate to the clay pan layer, hence to flow, unrestricted by frost, along subterranean channels of ever-increasing size. When the upper layers of soil finally thawed, they dropped into these enlarged subterranean channels to produce raw, open gullies approximately two feet deep and not confined by the berms of the original outlet ditch.

By installing ten drop structures at fifty-foot intervals the gradient was reduced from 8 per cent to 3 per cent. This resulted in a 34 per cent reduction of velocity and 75 per cent reduction in the cutting power of the waters when flowing at the calculated maximum for a ten-year frequency. Whereas the design has been modified in section, it has also been calculated to receive the discharge from two terraces of an adjacent farm not called for in the original plan. Fig. 1 shows the whole outlet system immediately after construction.

The use of the new interlocking steel piling has made possible a 50 per cent reduction in form work, and a uniform headwall and weir further reduced the cost of construction. The completed job cost approximately two-thirds of the estimated cost for all concrete, and it is believed that adequate protection and permanency is guaranteed.

In Fig. 2 we have a "worm's-eye view" of the transition section leading to the first drop structure. It is cobblestone paved, asphalt grouted and dusted with gravel, and is designed to take the discharge of the top diversion terrace which is at right angles to the outlet. It serves to transpose direction as well as shape, being a very flat trapezoidal section at the terrace end and merging into a rectangular section at the weir of the drop structure. This view also shows the small steel piling used as entrance deflectors to aid in directing the flow and reducing head turbulence at the weir.

All the drop structures are of similar section though the overfall and apron length varies. The first pieces of steel piling adjacent to the headwall were cast into the concrete by notching the forms and embedding half of the web in the headwall. When the forms were removed, the remainder of the interlocking steel piling was driven into place in the partially backfilled portion above the headwall; then clay was tamped tightly against the inside walls of the piling and the backfilling and grading operations completed. The channel immediately above each section has a gradient of 3 per cent with side slopes at 4 : 1. All of each earth channel section is to be maintained in a permanent grass cover.

To emphasize the contrast under identical conditions, several structures employed the use of the interlocking steel piling as wingwalls for the apron (Fig. 3), the others being the conventional type of cast concrete. On the lower side the backfill was placed to the desired elevation to hold the piling rigid and the concrete apron was cast directly using the piling for the side forms. No clay was used in backfilling the apron sections.

In its various other uses the interlocking steel piling may be subject to considerable seepage, but as the calculated water velocity here is approximately six feet per second, the losses due to seepage will be negligible. In each case the length of the piles was predetermined and ordered cut to length which insured penetration below the impervious clay layers and also a safe depth below the frost line. Interlocking steel piling may be obtained in many sizes; that used in this experiment was four inches wide with a one inch double crimp and made of No. 16 gauge heavily galvanized.

First publication in AGRICULTURAL ENGINEERING. The author is project engineer, Winooski River, Vt., area, Soil Conservation Service, U. S. Department of Agriculture.

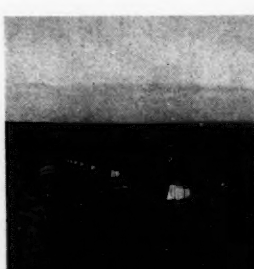

Fig. 1 (Left) The outlet system, in which interlocking steel piling was used, immediately after construction. Fig. 2 (Center) A view of the transition section leading to the first drop structure. Fig. 3 (Right) Close-up of the interlocking steel piling used as a wingwall for the apron

Heat Production of Farm Livestock

By M. A. R. Kelley
FELLOW A.S.A.E.

VITAMINS, amino-acids, carotene grams, and calories are terms familiar to nutritionists. To the layman they are more understandable when expressed as milk, meat, or carrots; and to the engineer, more useful when expressed in terms of pounds and Btu. As a member of the (A.S.A.E.) Committee on Air Conditioning of Animal Buildings, I have endeavored to state our ignorance and to summarize the available data on the subject of heat production of farm livestock for the purpose of farm building design.

We agricultural engineers have been fortunate in having the cooperation of Dr. Kriss[a] and Dr. Mitchell[b] who have been valuable aids in the work of our committee for the past several years. We are glad to welcome the help of other nutritionists.

Some twenty years ago Dr. Armsby[c] was asked to help us develop the basic data so essential to our work. Dr. Kriss was assigned to this task and published in 1921 the paper entitled "Some Fundamentals of Stable Ventilation"[1]*. This work constituted a landmark for the development of sound engineering practices in the proper ventilation of stables. Since that time other helpful studies have been made.

This paper is intended to summarize pertinent available data. For convenience of use and conciseness of presentation, the estimated heat production for dairy cows and that for hogs are given in the form of curves; that for poultry in the form of a table, because of the importance of data for chicks as well as for mature birds. At present, because of the meager data available on horses and sheep, data on only the average animal is given. This will be helpful until further studies are made.

The graphs shown in Fig. 1 are based on data from Armsby and Kriss (Table IV, p. 354)[1] and represent data for a cow under average feed and production. Definite heat production from a cow of a known weight and production permits calculations for other weights by use of Rameaux's law. This law shows that the heat production varies as the two-thirds power of the body weight (Fig. 1). More recently Kleiber[3] and Brody[5] have shown, when applied to basal metabolism, a remarkable relationship of this body weight to the 0.73 power, as applicable for a wide range of animals, from mice to elephants. Our present use of this relationship, as applied to metabolism under normal feeding, is limited because of the many factors which affect the heat production under practical conditions. It is of interest to note an average difference of 2.8 when compared with the curve of Fig. 1, being slightly less for weights under 1200 lb and a little higher for the heavier weights. Trial calculations for other farm animals shows a different ratio needed.

Requests are frequently made for information on the heat production of poultry. Since the original publication from which these data were obtained is now out of print[6], the information is condensed and the terms transposed and presented in Table 1.

Figs. 2 and 3, showing heat production for hogs, are given for convenience of reference. More detailed information is found in a recent paper by Mitchell and Kelley[7].

The information now available on the heat production of horses appears inadequate for engineering design. In our tests[2] of two different barns and with heat units given by Armsby and Kriss used to estimate heat production, results obtained were incompatible when used for comparison of the cow stable with the horse stable in the same barn. Notwithstanding an estimate of the heat produced by a horse as but 60 per cent of that by a cow, a higher stable temperature resulted. Brody *et al*[4] reveal that the basal and resting metabolism (lying at rest) for a horse of 1000 lb weight is 30 per cent above that of a dairy cow of like weight. It appears no longer necessary to consider that

This article is especially prepared for agricultural engineers for the purpose of furnishing them with valuable basic data not readily available for reference. The author is agricultural engineer, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture.

[a]Dr. Max Kriss, professor of animal nutrition, Institute of Animal Nutrition, Pennsylvania State College.

[b]Dr. H. H. Mitchell, chief in animal nutrition, department of animal husbandry, Illinois Agricultural Experiment Station.

[c]Dr. H. P. Armsby (deceased), at the time director, Institute of Animal Nutrition, Pennsylvania State College.

*Superscript figures indicate references cited at the end of this paper.

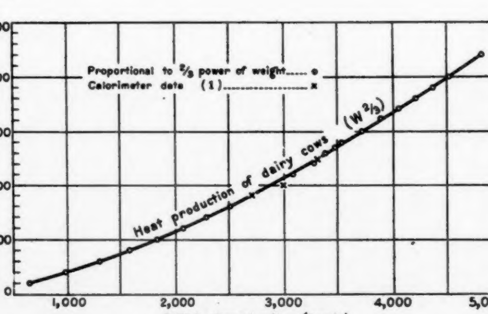

FIG. 1 HEAT PRODUCTION OF DAIRY COWS

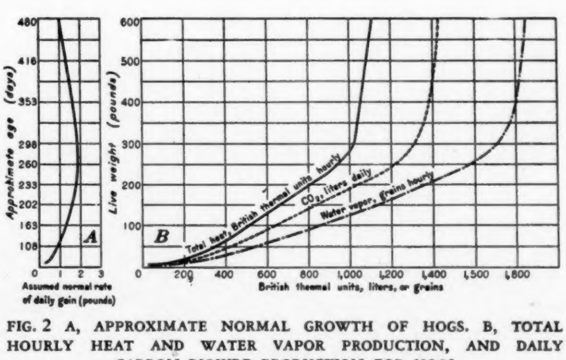

FIG. 2 A, APPROXIMATE NORMAL GROWTH OF HOGS. B, TOTAL HOURLY HEAT AND WATER VAPOR PRODUCTION, AND DAILY CARBON DIOXIDE PRODUCTION FOR HOGS

the metabolism under normal conditions of feeding and activity of a horse would be less than that of a cow. If we assume that for the metabolism of the average horse, the same ratio holds as that shown for basal metabolism by Brody, the average farm horse of 1350 lb weight would produce 4,510 Btu per hour under normal metabolism. Such data would be more in agreement with results obtained under farm conditions and cited above[2].

Metabolism data for sheep are at present meager and not readily available. Both Ritzman[9] and Mitchell[8] have made such studies, but as yet their data have not been translated into engineering terms. In Table 2 we have used Armsby and Kriss data for cows and sheep[1], and these will serve until additional studies make further refinement possible. Table 2 summarizes these available data on the basis of average sizes of adult.

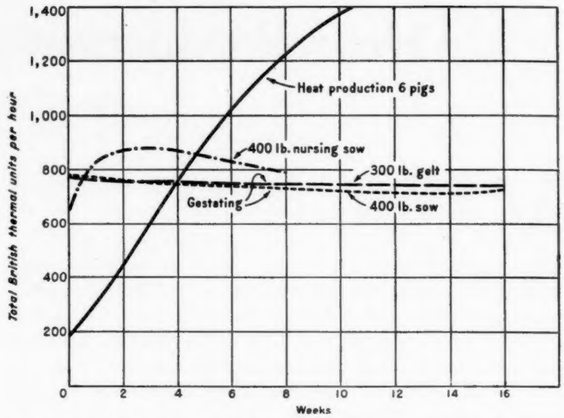

FIG. 3 HOURLY HEAT PRODUCTION OF GESTATING AND NURSING SOWS AND A LITTER OF SIX PIGS

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TABLE 2. HEAT PRODUCTION OF AVERAGE LIVESTOCK UNDER ORDINARY FARM CONDITIONS

Species	Live weight, lb	Heat produced hourly, Btu
Dairy cow	1000	3000
Swine	300	1025
Fattening lamb	80 - 90	330
Turkey	15	119
Goose	12	81
Duck	6	62
Hen	5	46

TABLE 1. HOURLY HEAT PRODUCTION OF FARM POULTRY AND THE WATER VAPORIZED DAILY PER BIRD*

Body weight, lb	Bronze turkey			Emden geese			Pekin ducks			White Plymouth Rocks		
	Age, weeks	Production of heat, Btu/hr	Production of water, lb/day	Age, weeks	Production of heat, Btu/hr	Production of water, lb/day	Age, weeks	Production of heat, Btu/hr	Production of water, lb/day	Age, weeks	Production of heat, Btu/hr	Production of water, lb/day
0.077										0	1.65	0.015
0.115	0	3.3	0.030									
0.126							0.0	2.88	0.026			
0.215				0.0	4.6	0.05						
0.5	3+	19.0	0.18	1.7	18.7	0.17	2.0	16.0	0.15	4.6	13.6	0.12
1.0	5+	28.1	0.26	3.1	25.4	0.24	3.2	22.3	0.21	6.7	18.2	0.17
1.5				3.8	30.0	0.28	4.1	27.4	0.25	8.9	22.3	0.21
2.0	8	39.5	0.37	4.4	33.9	0.31	4.8	32.3	0.30	10.7	26.3	0 24
3.0	10—	47.4	0.44	4.6	40.0	0.37	6.2	41.6	0.38	14.9	33.0	0.31
4.0	11	54.0	0.50	5.8	44.6	0.41	7.5	49.6	0.46	19.4	39.3	0.36
5.0	12+	60.3	0.56	6.9	50.9	0.47	8.9	56.5	0.52	25.4	46.2	0.43
6.0				8.2	56.0	0.52	11.1	62.0	0.57	23.3**	51.2	0.47
7.0	15	72.2	0.66				13.8	66.8	0.61	**	58.5	0.54
8.0				11.1	64.8	0.60	**	67.3	0.62			
9.0							**	78.2	0.72			
10.0	19	91.4	0.84	14.5	73.7	0.68						
12.0				18.7	81.5	0.75						
15.0		118.8	1.09	27.5	92.7	0.85						
18.0				45.4	102.0	0.94						
20.0	52	132.4	1.21		108.1	1.00						
26.0				**	133.1	1.22						
36.0	104**	208.6	1.92									

*These data arranged from reference[6].
**Male birds.

Weed Control Machinery and Control Methods in Utah and Idaho

By E. M. Dieffenbach
MEMBER A.S.A.E.

THE Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture, in cooperation with the Utah Agricultural Experiment Station for nearly three years has been conducting investigations of weed control machinery, with headquarters at Logan, Utah. This paper covers observations made in these cooperative investigations of machinery and methods used for weed control, principally in Utah and Idaho.

In common with other irrigated and adjoining lands in the western United States, some of the most troublesome weeds in Utah and Idaho are wild morning-glory or field bindweed, white top or perennial pepper cress, Canada thistle, perennial sow thistle, and Russian knapweed. All of these weeds are perennials and are difficult to control or eradicate, once they are established.

Where a farmer wishes to participate in the weed eradication program, he signs a contract with the county agreeing to pay a specified amount for the cultivation or other treatments. In my contacts with the eradication work in numerous counties in Utah and Idaho, I have noted quite a variance in the amount charged farmers for the cultivations. Some of the prices charged by different counties are $8 per acre per year, $6 per acre per year, $6 per acre per year up to 12 cultivations; and 50 cents per acre per cultivation. Free cultivations are being tried in one Idaho county.

According to figures issued by the Works Progress Administration, the actual costs of cultivation in Utah exceeded considerably the amounts charged the farmers. During the 1939 season, for instance, the lowest total cost per acre per treatment for power cultivation for any county, including charges for overhead, was $1.00, and the average total cost per acre treatment for power cultivation was $1.72 per acre. Summarizing costs for power cultivation for the entire state of Utah, according to the W. P. A. figures, the cost of cultivating white top an average of 7.5 times was $11.92, and the cost of cultivating morning-glory an average of 12.77 times was $22.39. In partial explanation of these apparently high cultivation figures, it should be mentioned that in many cases the fields cultivated are small, sometimes less than an acre in size. Where fields are larger, a cost of 50 cents per acre per cultivation with a duckfoot or blade weeder would ordinarily be considered a fair charge. In one Idaho county 280 acres were kept under clean cultivation during the past season at $6.00 per acre. According to the weed supervisor of this county, with the W.P.A. furnishing the labor to run their tractor, the county will have the tractor about one-half paid for at the end of this season at the $6 charge.

Some of the contracts between the farmer and county under the weed program are signed for a period of one year, while in other counties the contract covers more than one year. The tendency in Utah at least is to increase the tenure of the initial contract to at least three years. It is felt that the land should be kept under clean cultivation until it can be pronounced clean by the local committee, and that the first year's crop should be selected on the approval of the committee. This will usually be a crop that can be kept cultivated and watched carefully for stray weeds.

Equipment owned by counties for use in weed eradication work is similar in the states of Utah and Idaho. Both have considerable irrigated land, and also land farmed without irrigation. The counties participating in the program usually have at least one tractor, plow, disk, and duckfoot cultivator or blade weeder. The counties also have some horse-drawn weeding equipment, which is sometimes operated by the county and sometimes loaned to individual farmers who wish to do their own work. A few counties own power sprayers with which to apply chlorates to spotted weed infestations; however, most of the chlorates are applied dry by hand. Most of the counties own one or more carbon bisulphide guns. Other miscellaneous equipment owned by counties for weed control usually includes burners, scythes, shovels, hoes, and other hand tools.

Approved by the Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture (Manuscript No. 3154), for first publication in AGRICULTURAL ENGINEERING. The author is associate agricultural engineer, Bureau of Entomology and Plant Quarantine (and was formerly with the Bureau of Agricultural Chemistry and Engineering), U. S. Department of Agriculture.

(LEFT) DUCKFOOT CULTIVATOR USED IN CLEAN CULTIVATION. (RIGHT) APPLYING CARBON BISULPHIDE FOR WEED CONTROL

A tractor of 14 dbhp or more is most commonly used for clean cultivation for weed eradication. Those of about 14 dbhp are the most numerous, but there are many counties with the larger tractors. In several cases, the smaller tractors were found inadequate, as when rocky soil was present, and were traded in on larger models. In one Idaho county a small diesel tractor of the track type is used. In a Utah county, the larger tracts of land are cultivated with two medium-sized track type tractors loaned for the purpose by the county road department.

Clean cultivated areas under the weed program are usually scattered over the county, so the mobility of the tractor is an important factor. All of the wheel type tractors are mounted on rubber. In some instances, tractors with high road speeds are used. Trailers, usually of the low two-wheeled type, are frequently used to haul the cultivators and other implements behind the tractor from field to field. In other cases, when the cultivator is also on rubber tires, a trailer is used to transport the operator's car from field to field.

CULTIVATORS FOR WEED CONTROL

The most popular cultivator in use in Utah and Idaho in clean cultivation is the duckfoot type, and is usually drawn behind the tractor rather than attached. In Utah the duckfoot sweeps are usually from 10 to 15 in in size, with the 14 and 15-in widths the most popular. In Idaho the tendency seems to be toward the use of larger sweeps. The widest sweeps seen in use during the past season were in Owyhee County, Idaho, the two front sweeps being 29 in wide. The larger sweeps usually have an advantage in less tendency to choke. However, they usually have more tendency to leave furrows behind the sweeps. Most of the duckfoot cultivators drawn behind tractors have a mechanical lift that can be operated from the tractor seat. The depth control on this type of cultivator is usually difficult to operate from the seat of the tractor, and is regulated by turning a nut on a threaded shaft. Where the sweeps are attached to the front or rear of the tractor instead of being drawn behind, they can usually be raised or lowered by means of a hydraulic or mechanical lift on the tractor. In clean cultivation for weed control the usual depths maintained are from 3 to 5 in. Within practical limits it is usually considered that the deeper the cultivation, the longer the period required for regrowth. In usual practice the rear sweeps leave the ground alternately ridged and furrowed, and a drag is used to help correct this condition. The tendency to furrow is also sometimes corrected by using flatter or smaller sweeps, or both.

Next in popularity to the duckfoot cultivator is the blade type of weeder. On a 12-hp tractor, for instance, a 6-ft grader blade is attached to the beams of a two-way plow. The blade is inverted from its customary position on a grader, and is attached with the concave side down, tilted slightly forward when in running position. This blade type of weeder has several advantages, one being its comparatively low first cost. When purchased new, a grader blade 6 in wide costs about 60 cents a foot; and when a partially worn blade is used, the cost is even less. When attached to the hydraulic or mechanical lift of the tractor, the blade weeder is easy to handle. When used often enough to keep the ground loose, as is the usual case during clean cultivation for weed control, the power requirements of the blade type of weeder are not much different than for the duckfoot type. In case the blade type is used repeatedly, it usually has a tendency to work shallower at each cultivation, and finally some other tool has to be used before the blade weeder can be used again effectively. The blade type of weeder has a hard time of it in rocky soil.

The rotary rod weeder is not used to any great extent in the weed eradication program in Utah and Idaho counties. Box Elder County, Utah, used rotary rod weeders in its weed eradication program during the 1937 season, but was forced to give them up due to excessive packing. Much of the land under the program was rather heavy, and the rod weeder worked shallower at each cultivation, until after two or three cultivations it was necessary to plow the land again. This summer plowing, besides being an extra expense, had a tendency to leave the land in a dry cloddy condition not conducive to weed growth, causing roots to go into dormancy instead of sending shoots to the surface.

In some counties tractor-drawn cultivators are supplemented with horse-drawn cultivators for the smaller fields. In other counties, horse-drawn tools are used exclusively. In some cases, these horse-drawn cultivators are of the duckfoot type, but in Utah especially, they are generally of the blade type. The blade is attached to three or more goosenecks, which in turn are attached to a cross timber. The doubletrees are attached to this timber. A wide board several feet long runs to the rear from the timber. The operator stands on this board, and by shifting his weight forward or backward, he can partially regulate the depth of the blade. The manufacturer of this blade weeder recommends that one horse be used for about each 3 ft of blade. This blade weeder has given good results in weed eradication in many cases. As on the tractor blade weeder already mentioned, this blade weeder has a tendency to work to the surface on repeated use, and some other tool of the digging type must be alternated with it for effective work.

In addition to the duckfoot cultivators and blade weeders already mentioned, a number of specially made weeders have been used successfully in Utah and Idaho. In Owyhee County, Ida., a V-blade weeder has been made attached to a subsoiler frame. It has two blades, each 9 ft 4 in long, and has a total cut of 9 ft 6 in. It is reported to be doing good work in the heavy bottom land for which it was constructed. In Emery County, Utah, a farmer made a weeder suitable for his occasional use by attaching a blade to an old alfalfa cultivator.

CHEMICAL METHODS FOR UNCULTIVATED AREAS

The use of chlorates in weed eradication is usually reserved for areas not suitable for cultivation, such as ditch banks, fence lines, and roadways. A few counties are applying the chlorates in the form of a spray, but most of them are applying it dry. The ones that prefer to use chlorates as a spray, use a truck-mounted sprayer of the type used for orchard spraying. In most of the spray crews observed, one or two men operate one or two spray guns, respectively, while other men look for the weed patches to be sprayed. The chlorates applied dry are usually spread by hand. I have not heard of any of the two-wheeled spreaders used in some other states, being used for applying dry chlorates in Utah or Idaho.

Considerable carbon bisulphide has been used in the two states for the smaller weed patches, especially in Idaho. At the present time, most of this chemical is applied with a "gun" manufactured by a western supplier of carbon bisulphide. This gun is a labor saver, for by its use one man can make the hole, measure the liquid, and force it into the hole. The hole may be tamped shut by the heel of the operator, or it may be closed by an additional man with a wooden tamp.

In some counties, burning of weeds that have gone to seed has been done by use of *(Continued on page 440)*

Temporary Silos for Grass Silage

By H. C. Smith
ASSOCIATE A.S.A.E.

TEMPORARY silos are, collectively speaking, those which are dismantled or taken down when not in use. They are mostly used as reserve silos which may be quickly set up when needed. When not needed, the construction materials are stored out of the way in a relatively small space.

Sufficient temporary silo lining paper has been purchased, to my knowledge, in the twelve year period ending in 1939, to build (in round figures) 332,000 silos of 40 to 50-ton capacity. Annual sales have progressed steadily, indicating repeated use of these silos by a large number of farmers as well as a fair yearly increase in the number of silos used.

In 1928 a group of farmers in east central Kansas counties decided to ensile a drought-stricken corn crop. Lacking the time and perhaps the money for the more permanent type of silos, these farmers set up circles of fence material and lined them against air infiltration with a variety of building papers. The raw untreated building paper became softened by the moisture in the silage, and failed to exclude the air.

LINING PAPER MUST RESIST SILAGE ACIDS, BACTERIA, MOISTURE, AND WEIGHT

In 1932 a new paper lining treated to resist silage bacteria was put out in a few territories. At the same time a carefully written and illustrated guide for the construction of this type silo was published. Some attention, even then, was paid to crop conditions in connection with ensiling. This latter phase of the work has culminated in three years testing of temporary silos filled with grass silage. The new product plus the clear building instructions proved to be a success. Despite the history of 332,000 farm-constructed silos, disappointments in the silo have been less than one-half of one per cent.

The preservation of forage crops has proven of rapidly increasing interest in the last few years. Originally we faced this problem with paper covers for outdoor stacks of cured hay. When properly applied and held in place on the stack, such covers are quite practical in all climates for periods up to one year. But the labor of curing hay emphasized the desirability of ensiling forage, if possible.

Accordingly on July 21, 1937, three small 8-ft diameter temporary silos were filled with alfalfa hay of approximately 32 per cent dry matter content at the Ohio Agricultural Experiment Station[1]. A shortage of alfalfa made it necessary to limit the height of these silos to 8 ft. The last to be filled was stopped by shortage of grass at 4 ft.

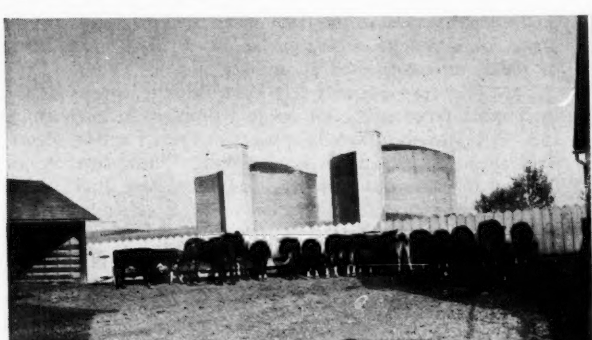
A.I.V. acids and molasses were used as preservatives. The 4-ft high silo was filled with alfalfa containing just 67.5 per cent moisture and no artificial preservative. None of these three first grass silos were completely satisfactory, but enough was learned from them to justify nineteen trials in 1938. In 1939, thirty-three grass silos were put up under controlled conditions at points from Van Nuys, Calif., to Sussex, N. J., with a total capacity of 4792 tons. Of these, two silos representing approximately 38 tons were not a practical success. Here again, however, important lessons were learned, for the improvement of this type of silo for this type of silage. The silo at the West Tennessee experiment station, Jackson, Tenn., contained 87.5 per cent moisture content clover and rye grass at the silo, to which was added molasses diluted two to one with water. Moisture ran off at a surprising rate from the bottom of the silo and apparently carried away a substantial amount of the preservative with it. Perhaps 40 per cent of the silage by weight was lost through spoilage over a six-month storage period.

No. 10 silo at Fayetteville, Arkansas, was filled with green oats and molasses which spoiled about 20 to 25 per cent, because the silo lining paper was unfortunately left attached to the fence and therefore was torn as the silage settled. This silo was filled May 29, and was opened for feeding in January 1940.

By contrast twenty-nine of these thirty-three silos were 100 per cent satisfactory. Crops which included Johnson grass, drought-burned wheat, dry and green oats, alfalfa, timothy, alsike, lespedeza, bluegrass, pea vines, and crab grass came through 4 to 11-mo storage periods in almost perfect shape, and in some cases as surprisingly good feed for the condition or nature of the crop.

Presented before the Farm Structures Division at the annual meeting of the American Society of Agricultural Engineers at State College, Pa., June 17, 1940. The author is in the technical service department of The Sisalkraft Co.

[1]Bi-Monthly Bulletin No. 192.



The temporary silos at the left, made up of welded wire and Sisalkraft are on the Anderson Farm near Ontarioville, Ill. The feeding racks are permanent, and the silos are built on the same spot year after year. The silos at the right, made up of slat fencing and Sisalkraft, are on the Shute Farm near Valparaiso, Ind.

This experience led to conclusions as follows:

1 Summer climatic conditions are hard on temporary silos. Lining them with two sheets, a double layer of treated paper, is recommended. One of the two sheets can be used again, so that the additional protection does not seriously increase the cost.

2 Temporary silos should not be built more than a few feet higher than their diameter.

3 Silos less than 12 ft high need weighting on top for best preservation of the silage.

4 Grasses should not be ensiled actually in the rain in temporary silos. A short wilt or drying period after a heavy rain is advisable. Excessive moisture often results in excessive draining of the silo, with consequent losses of soluble minerals and artificial preservatives. It is assumed in this connection that grass for silage is cut immature, in the early bloom stage.

5 Hydrochloric and sulphuric acid combinations should not be used as preservatives in temporary silos lined with present treated paper. A special product for this type of silage is contemplated in the event of an increase in its popularity.

6 Mixed grasses for ensilage are interesting and often desirable. For instance, mixed grass and soybean silage seem more palatable than straight soybean silage.

7 A 2x4-in mesh, 11-gage welded steel silo fabric 48 in wide is the safest, strongest, and easiest fencing material to use in temporary silo construction.

8 The highest moisture content grass should be ensiled last. It is important also to have plenty of artificial preservatives in the final loads in the silo rather than to oversweeten the first loads and then skimp on the last loads.

9 Grass silage should be chopped fine. Silage in small silos should be cut to 1/4 in. It is worth while to sharpen the cutter blades each noon hour when silo filling is carried on for several days.

10 Grass silo filling need not be organized on a corn silo filling basis. Three men working together can set up a temporary silo, mow, gather, and ensile the grass. It may take longer in days of time, but it costs less than gang-filling operations and should not affect the quality of the silage.

QUESTION OF FARMER'S ABILITY TO SUCCESSFULLY HANDLE GRASS SILAGE

Although these experiences indicate that all tested types of grass silage may be ensiled with safety in temporary silos lined with treated paper, this fact will not be advertised for general farm use until we are convinced of the farmer's own ability to successfully ensile and preserve these types of silage. We are, however, pleased to cooperate with any agricultural authority in educational programs involving grass silage and temporary silos. Seven silos, for instance, will be furnished and filled at "forage schools" held in various counties by the Mississippi State College extension division this summer. The flexibility of these silos and the speed with which they may be erected make them quite suitable for this type of field educational work.

There are a few points in the construction of temporary silos that should be emphasized, as follows:

1 Have silo site as level as possible.

2 Apply paper lining loosely in order that the encircling fence material may take full weight of silage.

3 Mix and distribute fine and coarse particles evenly during silo filling.

Parallel studies and work have been carried on by associated paper manufacturers in England and Australia. The Minister of Agriculture for the British Empire has recently arranged for a special allotment of paper pulp in order that paper silos may be available "for the conservation of home-grown cattle feed".

Weed Control Machinery and Control Methods

(Continued from page 438)

hand burners using kerosene or distillate for fuel. This burning is done for seed control in the case of perennials, with the realization that the roots are not affected by the burning any more than if the tops were cut off with a hoe or similar tool.

Based on contacts made with many of the men in charge of the weed eradication work in Utah and Idaho, and after personal observation of much of the equipment used, I would like to discuss some of the conditions observed; these comments on equipment and methods are not made in the spirit of criticism, but rather are given in the spirit of cooperation and from the standpoint of the agricultural engineer:

1 Few counties consider ready-made cultivators entirely adequate. The most popular alteration of standard equipment is the installation of wider sweeps.

2 In most of the counties observed, new acreage is admitted into the clean cultivation program at any time of the year. As a result, when land is taken into the program and plowed in midsummer it is usually too dry unless irrigated. It would seem that it would be more advisable in most instances to begin the clean cultivation of fields with fall plowing. This practice will usually admit earlier working in the following spring, and will usually insure plenty of moisture all summer for steady weed growth without irrigation.

3 Nearly all of the fields of any size observed which are under clean cultivation are somewhat spotted as to soil formation. Some of the fields have portions which are "chalky" or sandy and in which the tractor and cultivator tend to bury themselves. Depth control on the cultivators observed, especially on the cultivators pulled behind the tractor, cannot be changed readily enough by the operator while on the tractor seat. As a result, one cultivator setting is usually used for the entire field. This "compromise" setting usually takes care of most of the field satisfactorily, but allows too deep cultivation in the soft places and too shallow cultivation in the hard spots. Lack of flexible regulation of depth of cultivation seems to be a shortcoming of most cultivators used at present.

4 The deep furrows left by wide rear sweeps of the duckfoot type of cultivator create a problem in many counties. A regrowth of weeds appears in these furrows several days ahead of growth on level ground. These furrows are covered in some counties by a timber or pipe drag behind the cultivator at each cultivation or every other time. The chief objections to these drags are their pulverizing of the soil and the power they require. It would seem that a better solution of the furrow situation would be to start the program with fall plowing, if desirable for the particular land to be worked, and to otherwise get the land in better condition before trying to cultivate. Following proper preparation of the land, sweeps of normal width and of the type designed to leave the ground flat could be used.

The Role of Nickel in the Production of Farm Tools

By H. L. Geiger
MEMBER A.S.A.E.

(Continued from October)

PART II. CAST IRON

IN THE farm tool field there are numerous parts, both from the economical and physical properties standpoints, which are best made of grey iron. General familiarity with the process of remelting pig iron in a cupola to produce grey irons of controlled carbon and silicon contents makes it unnecessary to go into details. Basic characteristics of the product produced by this process should, however, be discussed to understand the effects of alloy. Plain grey iron is made usually within the following chemical analysis range: Total carbon, 2.60 to 3.50 per cent; combined carbon, 0.30 to 0.75 per cent; silicon, 1.40 to 2.20 per cent, and manganese, 0.40 to 0.90 per cent.

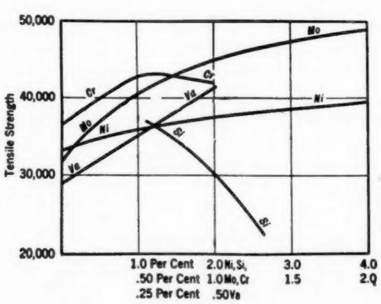
Brinell hardness values will range from 160 to 200 and the tensile strength will vary from 25,000 to 38,000 psi, depending on analysis and care exercised in the melting and casting operations. The lower strength metal has a coarse grain, sometimes open in structure, with large graphite particles.

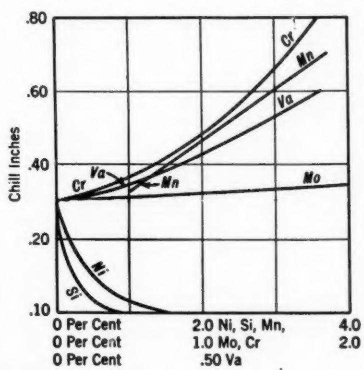
In thin sections, particularly where the silicon is on the low side, the metal may chill during freezing, producing localized hard spots which may run as high as 45 and 50 Rockwell C in hardness, which frequently causes damage to cutters in subsequent machining operations.

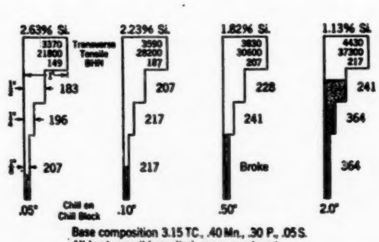
This danger of chilling is minimized by holding silicon content on the high side. However, where increased strengths are needed this is not always the best procedure to follow, as coarse and open grain coupled with a weak iron may result. Consequently the foundry resorts to the use of alloy to improve the structure and strength, and to gain additional properties not found in plain iron. The addition of nickel alone or in combination with chromium or molybdenum has become standard practice among the farm tool manufacturers where these improved properties are desired. Usually the first question raised concerning the value of an alloy is to what extent it will improve the tensile strength. Here, usually, the interest ends. Since other factors of importance are frequently overlooked, the following list of some of the more important functions of nickel in iron are presented:

1 Raises the tensile strength
2 Eliminates chill
3 Raises cast hardness
4 Improves machinability at higher hardnesses
5 Increases wear resistance
6 Improves response to heat-treatment
7 Offsets chilling effect of chill forming alloys
8 Lowers notch sensitivity
9 Increases resistance to fatigue
10 Refines grain and graphite particle size
11 Contributes to vibration-damping properties
12 Raises modulus of elasticity
13 Retards deterioration at elevated temperatures
14 Retards growth under repeated heating and cooling
15 Decreases sensitivity to thermal shock
16 Increases resistance to compressive stresses
17 Improves shock resistance
18 Improves transverse strength
19 Lowers tendency to scoring with proper control of alloy and melting practice
20 Increases resistance to torsional loads.

Part II of a paper presented before the Power and Machinery Division at the annual meeting of the American Society of Agricultural Engineers at State College, Pa., June 19, 1940. Part I, covering steel, appeared in AGRICULTURAL ENGINEERING for October, 1940.







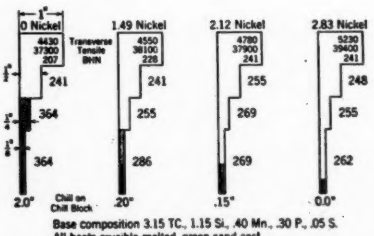


FIG. 13 (UPPER LEFT) EFFECT OF ALLOYS ON TENSILE STRENGTH OF CAST IRON. FIG. 14 (UPPER RIGHT) EFFECT OF ALLOYS ON CHILL DEPTH. FIG. 15 (LOWER LEFT) EFFECT OF SILICON CONTENT ON FORMATION OF CHILL IN GREY IRON. FIG. 16 (LOWER RIGHT) EFFECT OF NICKEL IN REDUCTION OF CHILL IN GREY IRON

These properties, all of which play some part in the farm tool picture, will be taken up as they apply to the parts under discussion. Since there are no SAE standard analyses for cast irons, as there are in the rolled steels, the use of alloys is judiciously guided by the properties desired.

In Fig. 13 is presented the strengthening effect of various alloys used in grey iron. It will be noted that the strength drops off rapidly with an increase in silicon content, whereas nickel, chromium, molybdenum, manganese, and others produce a direct strengthening effect. This strengthening effect would be expected to be greatest with alloys which have a tendency to form combined carbon, such as chromium and molybdenum. However, those alloys which are active in this respect are also active in producing the hard, brittle chill areas; consequently great care must be exercised to prevent unbalancing the structure by controlling the amounts used as a strengthener. As a rule these amounts are small, unless used with an alloy which will counteract the chilling tendency. Since nickel has the effect of counteracting chill and at the same time is a strengthener, its use in combination with the carbide-forming alloys to preserve the balance in an initially good structure is highly desired. Fig. 14 is presented to show the effects of the various alloys on the carbide forming tendency or depth of chill.

Straight nickel irons, but more commonly combinations of a 2 to 1 ratio of nickel and chromium or nickel and molybdenum, are regularly used to develop optimum in all properties.

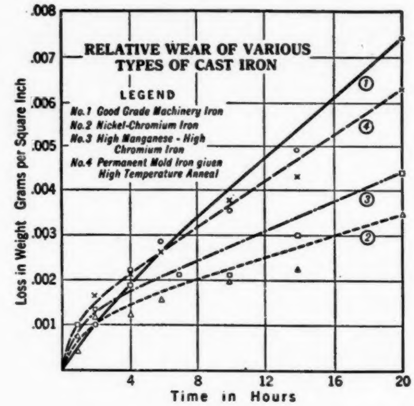
The use of nickel as a chill eliminator is being given more detail at this point as it probably affects a greater number of parts made of grey iron to a greater degree from the machining standpoint than any other one factor in farm tool production. The effects on chill formation in lowering of silicon content from 2.63 to 1.13 per cent in a 3.15 total carbon iron is shown in Fig. 15. The strength increases as the silicon decreases.

A direct increase in chill is to be noted with a decrease of silicon. Lowering of the total carbon also increases the tendency to chill. For test purposes the 3.15 per cent total carbon, 1.15 per cent silicon iron was treated with nickel additions from zero to 2.83 per cent (Fig. 16). A direct reduction of chill is to be noted in the step-bar test with an increase in nickel until at 2.83 per cent nickel, this low silicon iron has the same machinability and depth of chill as its high silicon (2.63 per cent Si.) predecessor. At about the same machinability, the nickel iron now has two times the tensile strength, with a slight increase in hardness. It also may be noted that there is an increase in Brinell hardness in the 1-in machinable section, a direct increase in transverse values, and an increase in strength, with increasing nickel additions.

Alloy iron for gears must be of a higher order of hardness to provide resistance to wear. At the same time it must be free of chill areas to facilitate machining of the teeth and the hub. Of necessity the material must be of a higher strength than plain iron in order to carry the loads.

TABLE 11. TYPICAL FARM TOOL GEAR AND SPROCKET CAST IRONS

	Total carbon	Si.	Ni.	Cr.	Mo.	BHN
1	2.80 - 3.20	1.50 - 2.00	0.75	0.35		170 - 190
2	2.80 - 3.20	1.50 - 2.00	1.00			170 - 190
3	2.80 - 3.20	1.50 - 2.00	1.00		0.40	190 - 220
4	2.80 - 3.20	1.50 - 2.00	1.00	0.45		180 - 210
5	2.80 - 3.20	1.50 - 2.00	1.25	0.65		200 - 230
6	2.80 - 3.20	1.50 - 2.00	1.50	0.75		210 - 240
7	2.80 - 3.20	1.50 - 2.00	1.75		0.50	220 - 265
8	2.80 - 3.20	1.50 - 2.00	1.50	0.40	0.30	230 - 275



	Iron Test No. 1	Iron Test No. 2	Iron Test No. 3	Iron Test No. 4
Total Carbon.	3.40	3.42	3.62	3.54
Graphitic Carbon.	2.95	2.90	2.82	3.54
Combined Carbon	0.45	0.52	0.80	Nil
Silicon	2.20	2.28	1.80	2.57
Manganese	0.70	0.77	1.24	0.62
Phosphorus.	0.30	0.245	0.286	0.643
Sulphur	0.08	0.061	0.141	0.107
Nickel.	None	1.23	0.18	None
Chromium.	None	0.21	0.56	None
Hardness-Rockwell B. Scale-Average (6-10 Readings) .	88	93	94½	86
Brinell Hardness.	174	197	199	167

FIG. 17 RELATIONSHIP OF RESISTANCE TO WEAR AND COMPOSITION OF PLAIN AND ALLOY IRON

These loads must be well under the limits of failure from compressive stresses which is about three times that of the tensile. The most desirable gear material would be one which falls in a 45,000 to 60,000 psi tensile range with a cast hardness of 200 - 265 Brinell number. The higher hardness provides greater resistance to wear, an observation noted in actual service[1] as well as in laboratory tests[2]. Fig. 17 taken from Huss' work indicates the superiority of the alloy iron to plain iron. Curves marked Nos. 1 and 4 are plain iron, while curves 2 and 3 are values for nickel-chromium irons, No. 2 having a 1.25 per cent nickel 0.20 per cent chromium content.

Increased nickel and chromium content attended by a high as-cast hardness would no doubt produce a curve below that of No. 2. Typical gear and sprocket analyses employed in farm tools are given in Table 11.

[1]Diefendorf, D. W. Iron as a gear material. Product Engineering, Feb. 1938.

[2]Huss, E. H. Long wearing irons extend pump life. Nickel Cast Iron News, Vol. 3, No. 4 (1932).

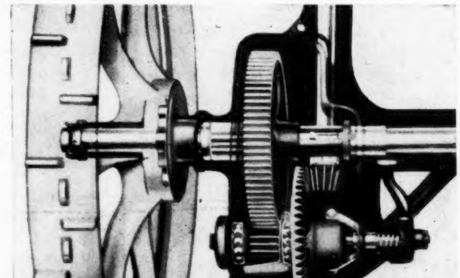
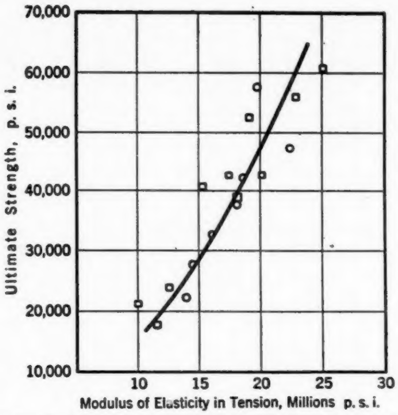
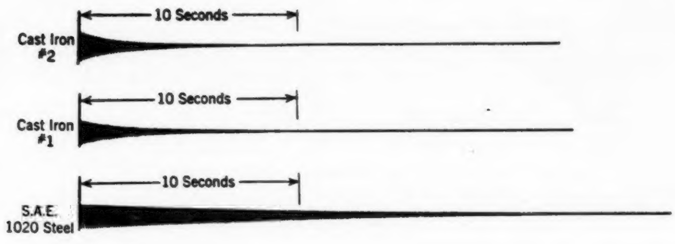


FIG. 18 MOWER GEARS OF NICKEL-MOLYBDENUM CAST IRON





ANALYSES

Top (#2 Iron)		Middle (No. 1 Iron)		Bottom (No. 3 steel)	
TC	3.06	TC	3.10	TC	.20
Si	2.20	Si	1.78	Si	-
Mn	.83	Mn	.61	Mn	-
Ni	.27	Ni	.86	Ni	-

FIG. 19 (LEFT) RELATION OF TENSILE STRENGTH TO MODULUS OF ELASTICITY OF CAST IRON. FIG. 20 (RIGHT) VIBRATION DAMPENING PROPERTIES OF CAST IRON AND STEEL

Brinell hardness in the cast condition will range from 170 to 265, and tensile values will be in proportion to the hardness ranging from a minimum of 35,000 psi in the first composition to as high as 55,000 psi in compositions 7 and 8. Choice of the analysis depends on the loads to be carried. Typical farm tool applications where these alloy iron compositions are employed, are gears for mowers (Fig. 18) and corn shellers, hand garden tractor ring gears, hay baler gears, wheel tractor power lift worms, gears and sprockets for silo fillers, combines, threshers and reapers, fans and gears in clover seed hullers, tractor oil pump bodies, and tractor ring gear hubs.

Another application where alloy iron has proven satisfactory has been for single-throw crankshafts of the type used for one-cylinder air-cooled engines used in small tractors and in individual small farm lighting units, crankshafts for corn shellers, diesel engine starting cranks, and other single-throw applications. High strengths are necessary, while higher resistance to wear on the bearing surfaces, together with the lesser tendency of the alloy iron to seize in the bearing, is in its favor. Higher torsional ultimate strength of the alloy irons is an advantage. Unlike steel, the elastic modulus or measure of rigidity varies over a rather wide range for cast iron, always in direct proportion to the tensile strength. For steel the modulus value, regardless of hardness, alloy content, or strength, is

TABLE 12. TYPICAL CRANKSHAFT CAST IRONS

Total carbon	Si.	Ni.	Mo.	Tensile strength, psi	Torsional ultimate strength psi*	BHN
3.20	1.20	1.50	.42	43,400	58,800	241
2.76	2.07	1.57	.69	54,100	74,000	255
2.39	1.77	1.80	.72	50,500	63,500	293
2.56	1.37	1.97	.72	51,300	75,700	293

*0.75-in diameter specimens.

30 million psi, whereas the modulus for iron has been reported from 9 million to as high as 26 million psi. Fig. 19 presents this relationship between tensile strength and modulus. The increase in rigidity with increasing strengths is an advantage when employing iron for crankshafts.

The nickel-molybdenum irons are favored because of the high strengths and toughness developed. Table 12 presents actual tests on nickel-molybdenum crankshaft irons. Usually tensile strengths run in excess of 50,000 psi. By redesigning the crankshaft with cored bearings and pins, appreciable weight reductions have been effected. With cast iron no restrictions are necessary upon the size and position of counter-weights. The total carbon of crankshaft irons should be below 3 per cent, if possible, a 2.50 to 3.00 range being preferred, and silicon should range from 1.40 to 2.00 per cent, holding under 1.90 if possible. Satisfactory results have been obtained on 1.50 to 2.00 per cent nickel, 0.40 to 0.80 molybdenum. One factor not shown by these tests and an important one for crankshafts is the inherently high damping characteristics of cast iron, which avoids the build-up of vibratory stresses, thereby contributing to smooth operation. Vibration damping curves of plain 1020 steel are compared with two cast irons, one with 0.27 nickel and the second one with 0.86 nickel, in Fig. 20.

Nickel obviously does not lessen this property of iron; consequently, the usual amounts which may be added for other reasons will not interfere with the damping property. Nickel also acts to increase the fatigue limit of cast iron in the same manner as in steel and acts to lessen to a larger degree than in steel the effect of notch sensitivity, thus minimizing the danger of failure by fatigue from alternate or vibratory stresses.

Motor castings for tractor water-cooled cylinder blocks and heads, air-cooled cylinder heads for single-cylinder motors used in hand garden tractors, cylinder liners both wet and dry, and pistons, generally contain nickel in various amounts in order to increase density and strength, to raise the overall hardness to provide increased wear, to minimize warpage, and to render the castings readily machinable. Typical compositions used for truck and automobile, and tractor motor cylinder blocks are presented in Table 13.

TABLE 13. ANALYSES OF NICKEL-CHROMIUM IRONS USED IN CYLINDER BLOCKS

Engine bore, in	Range of content of elements, per cent							
	Total carbon	Combined carbon	Silicon	Manganese	Phosphorus	Sulphur	Nickel	Chromium
3⅛	3.20-3.40	0.40-0.50	1.80-2.00	0.40-0.50	Under 0.20	Under 0.10	1.25-1.50	0
3⅝	3.20-3.40	0.35-0.45	2.30-2.50	0.50-0.60	Under 0.30	Under 0.12	1.00-1.25	0.45
5	3.20-3.40	0.40-0.50	1.75-2.00	0.50-0.60	Under 0.30	Under 0.12	1.25	0
4½	3.20-3.40		2.35-2.50				0.80-1.00	0.35-0.40
3¼	3.40-3.50		2.40-2.55	0.60-0.70	Under 0.50	Under 0.10	2.25-2.50	0
4½ and 5	3.20-3.35	0.35-0.45	2.35-2.55	0.60-0.80	Under 0.20	0.08-0.12	1.25-1.50	0.35-0.45
5	3.20-3.30	0.40-0.50	2.40	0.40-0.50	Under 0.30	Under 0.10	1.30	0.51
3 and 3¼	3.43		2.11			0.095	0.51	0.25
	3.20-3.30		1.90-2.10				0.75	0.25
3¼	3.40	0.50-0.60	2.15-2.30	0.65-0.70	0.18-0.22	0.08-0.09	0.70-0.80	0.30-0.35

TABLE 14. NI-HARD—CHILL CAST

Typical composition

Total carbon	2.7 to 3.6 per cent
Manganese	0.35 to 0.50 per cent
Phosphorus	0.2 max.
Sulphur	0.12 max.
Silicon	variable*
Nickel	4.25 to 4.75 per cent
Chromium	1.4 to 1.6 per cent

*Total carbon and silicon will vary according to the depth of chill required. The degree of hardness and strength desired will be governed by the total carbon content.

Typical Results of Tests of Chilled Plain and Ni-Hard Irons

	Plain iron		Ni-Hard	
	High carbon	Low carbon	High carbon	Low carbon
Brinell hardness of chilled surface	500	400	650 to 700	575
Tensile strength in chilled section, (psi)	35 to 40,000 (1)	48 to 53,000 (2)	55 to 60,000 (2)	70 to 80,000 (2)
Tensile strength in grey core (psi)	16 to 25,000	22 to 39,000	30 to 35,000	40 to 50,000
Total carbon	3.50	2.75	3.50	2.75
Silicon	0.75	0.75	0.75	0.75
Nickel			4.50	4.50
Chromium			1.50	1.50

(1) Calculated from transverse tests.
(2) Test pieces ground from chilled blocks to 0.800-in diameter A.S.T.M. Standard.

Replaceable liners have for some time been used in the heat-treated condition in tractor motors where the optimum in wear resistance is needed. The hardening power of cast iron depends upon the amount of combined carbon and other elements such as manganese, nickel, and chromium, which it contains. A cast iron containing 0.50 per cent combined carbon will react to heat-treatment much the same as a 0.50 per cent carbon steel. The alloying elements act much the same on the critical range in iron as they do in steels. Lower silicons which usually accompany alloys, increase the response to heat-treatment. Increase in most of the alloys also increases the hardening, as indicated in Fig. 21, of various iron compositions subjected to an oil quench from 1500 F and drawn at various temperatures.

For liners the practice has been to employ nickel additions between 1 and 2 per cent, together with chromium additions varying from 0.25 to 0.75 per cent, depending on the stability and hardness needed to be maintained at motor operating temperatures. Where high hardness at fairly high motor temperatures is desired, a nickel-molybdenum or nickel-chromium-molybdenum iron may be used.

Exhaust manifolds on tractor motors are now being made of nickel or nickel-chromium irons. Nickel reduces the tendency towards deterioration at higher temperatures and reduces considerably the growth which takes place in ordinary irons from repeated heatings and coolings. Nickel

TABLE 15. TABLE OF GENERAL PROPERTIES FOR NICKEL CAST IRON PARTS USED IN IMPLEMENTS AND TRACTORS

PARTS	Resistance to Wear (Ordinary)	Resistance to Wear (Exceptional)	Chill Elimination	Strength Under Tension	Cast Hardness	Heat Treat Hardenability	Resistance to Fatigue	Grain Refinement	Vibration Damping	Improved Machinability	Increased Modulus of Elasticity	Resistance to Growth at Elevated Temp.	Resistance to Compressive Stresses	Resistance to Impact	Low Tendency to Scoring and Galling
Pulleys			*							*					
Frames			*	*				*		*	*			*	
Crankshafts	*		*	*	*	*	*	*	*	*	*			*	
Plunger Rods	*				*					*					
Brake Drums	*		*					*		*	*		*		*
Gears	*		*	*	*	*	*	*		*	*		*		*
Clutch Plates	*		*		*			*		*			*		*
Sprockets	*		*	*	*		*	*		*	*		*		
Cylinder Liners		*	*			*		*		*	*	*	*		*
Valve Inserts		*	*		*	*	*	*		*		*	*	*	*
Cylinder Heads			*		*			*		*		*	*		
Motor Blocks			*		*			*		*	*	*	*		
Exhaust Manifolds			*		*			*			*	*	*		
Grinding Burrs		*			*									*	
Plow Points		*			*									*	

No.	1	2	3	4	5	6
Total Carbon	3.10	3.12	3.10	3.15	2.68	2.69
Silicon	1.69	1.08	1.13	1.76	2.31	2.36
Nickel	None	None	1.21	1.13	1.22	1.22
Chromium	None	None	0.39	0.45	0.33	None

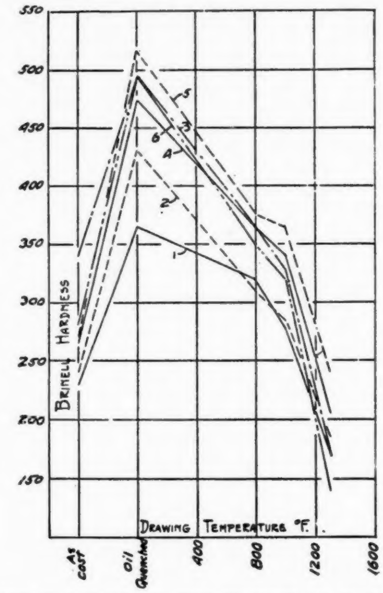


FIG. 21 EFFECT OF DRAWING TEMPERATURES ON PLAIN AND ALLOY CAST IRON AFTER QUENCHING IN OIL FROM 1500 F

in the range of 1 to 2 per cent, with 0.25 to 0.65 chromium, is the composition most commonly used. Low total carbon is favored and silicon in the 1.40 to 2.00 per cent range is desired.

Valve inserts are also specified in alloy iron for their resistance to repeated pounding by the valves, and resistance to deterioration at motor temperatures. A range of 0.50 to 1.50 per cent nickel, 0.30 to 0.70 per cent chromium, 0.30 to 0.50 per cent molybdenum covers the nickel-chromium-molybdenum iron combinations used for inserts.

Other items not already discussed are pulleys and clutch plates. As a rule, pulleys do not require the higher tensile strength irons, but must be dense and fine grained, as well as free of chilling on the thin flanged edge to prevent breaking and to permit machin- (*Continued on page 449*)

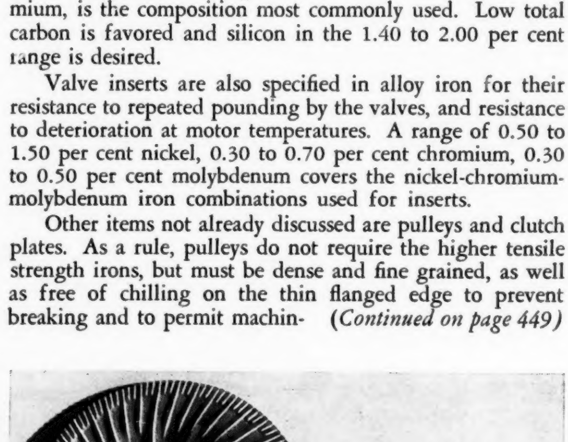


FIG. 22 SAND CAST NI-HARD GRINDING BURRS IN A RANGE OF SIZES

Studies of Artificial Lighting of Dairy Stables

By M.A.R. Kelley and A. V. Krewatch
FELLOW A.S.A.E. MEMBER A.S.A.E.

THE purpose of the tests described in this paper was to obtain further information on the best arrangement of lamps for use in lighting dairy stables and to determine present farm practices. A survey of the natural lighting of farm barns was also made and will be reported at a later date. In these studies the departments of agricultural engineering and dairy husbandry of the University of Maryland cooperated with the divisions of farm structures research and rural electrification research[1] of the Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture.

More than 60 Maryland farm barns were visited and twenty-five of these were studied with fifty or more different light combinations ranging from 25 to 200-watt lamps, and with lamps spaced from three to six stalls apart. The farm light combinations were then analyzed and new ones tried at the experimental dairy barn at the University of Maryland.

Instruments. A standard type of Weston light meter having 0-25, 0-50, 0-250 scale ranges and a two-cell paddle with an extension cord was used. Special cover plates or screens were made so as to obtain daylight readings. A convenient, light-weight tripod was made for the light meter. A handle four feet long permitted the operator to vary his position so as to avoid shadows and to facilitate quick movement. The tripod had a fixed height of one foot and all floor readings were taken at this height. In the use of this instrument there is, of course, an element of personal error in reading, and at the illuminations below one-half foot-candle the error in reading becomes larger. These data are presented without any attempt to make corrections for calibrations of instrument and should be accepted as such. Since, for the most part, the instrument was read and the paddle held by the same individuals, the personal errors are assumed to compensate.

Description of Stables. With the exception of four stables, all cows faced outward. Heights of lamps from the floor varied from 6.5 ft to 12 ft. Stable widths varied from 32 to 47 ft (with three rows of cows) some with raised feed alleys and others with high-front mangers. Bare lamps, diffusion globes, shallow dome and concealed reflectors, as well as angle reflectors from side walls, were observed in farm barns.

Since the University of Maryland barn varied somewhat from the ordinary farm barn, a brief record of the points of difference will permit greater appreciation of the test data.

Barn walls were made of 8-in concrete blocks, and beaded ceiling was used; both walls and ceiling were painted white, but the surface had been somewhat dimmed by service. However, except for newly painted or freshly cleaned surfaces, the conditions were above the average for most farm barns. The ceiling height at the center was 9 ft 2 in, varying with the gentle slope of the floor.

The entire stable housed forty purebred cows, Holsteins at one end of the stable and Ayrshires at the other. Ayrshires were used throughout most of the tests.

Manger height was 30 in in front and wood partitions extended to the top of the pipe rail of the chain-tie type of stall. Stall width was 4 ft and varied in length from 5 ft 8 in to 5 ft 10 in. The interior width of stable was 38 ft. It is evident that the extra width decreases light received at sides from center lamps, high-front mangers reduce light on floor of feed alley over that of raised alleys; and lack of stanchions adds a slight increment of light to feed alley over that of the average farm barn. Hence, like arrangement of lights as tested when used in farm barns and stalls of ordinary width and standard construction may be expected to give a slight difference in

Presented before the Rural Electric Division at the annual meeting of the American Society of Agricultural Engineers at State College, Pa., June 17, 1940. Authors: Respectively, agricultural engineer, division of farm structures, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture, and specialist in agricultural engineering, extension service, University of Maryland.

[1]The authors wish to acknowledge the assistance rendered by Harry L. Garver, agricultural engineer, division of rural electrification research, U. S. Bureau of Agricultural Chemistry and Engineering, in planning the study and in participation in the field work on several occasions.

(LEFT) BARN NO. 1 IN THE STUDIES REPORTED. IT WAS BUILT IN 1939 WITH CONCRETE BLOCK WALLS. THE LEFT WING IS FOR MILL FEED STORAGE AND THE RIGHT WING IS THE DAIRY. (RIGHT) THIS IS THE BARN IDENTIFIED AS NO. 6 F IN THE STUDY. IT IS TYPICAL OF NEW DAIRY BARN CONSTRUCTION IN MARYLAND

interior illumination in keeping with variations in construction.

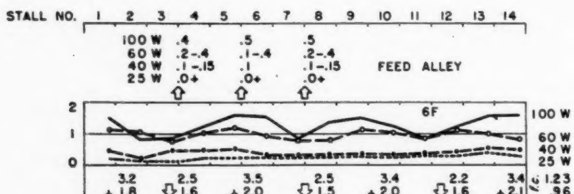
All floor readings were taken at a fixed height of one foot at milking point in stalls, directly under lamps and midway between lamps. The feed alley readings were made 3 ft from the side wall. Lamps in the litter alley were tried in the center, over the rear gutter line, under girders and 2 ft in front of girders. In some cases lamps were opposite and in other combinations staggered as shown in Fig. 4. Lamp spacings for 3, 4, and 5 cows were tried, being, respectively, 9, 12, and 16 ft apart. The total rated wattage varied from 120 to 800 watts with three to eight lamps in use.

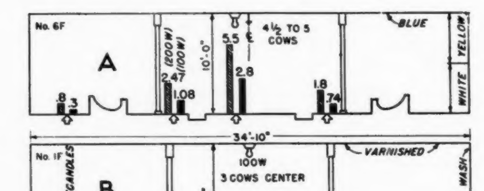
Presentation of Data. Table 1 shows the light readings obtained in the stables of some of the farm barns surveyed. These data are a fair sample of conditions with the lamp spacing varying from 3 to 6.5 stalls and size of lamps from 25 to 200 watts. These barns were approximately 34 ft in inside width and varied somewhat in ceiling height and wall finish. Barns 6 and 17 had high-front mangers and the others were of the "sweep-in" type.

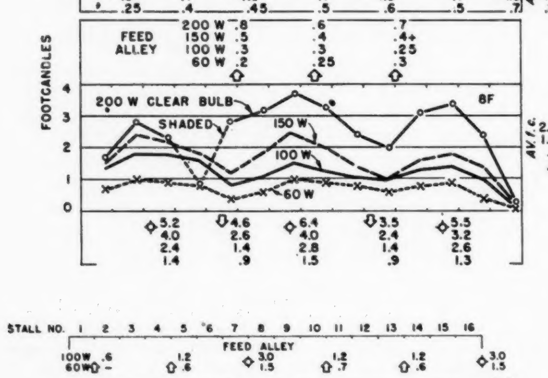
For detailed comparisons, the differences in the conditions within the stable will have to be considered. Table 1 gives briefly a sample survey of the light conditions as found in the modern farm barns which meet all the requirements for shipping milk into the city of Washington. Barn number 1, shown on the left of the accompanying picture, was built in 1939. Barn 6, at the right of the picture, is typical of many new barns in Maryland, while barns 8, 14, and 17 are somewhat older.

Fig. 1 shows data obtained in two modern barns ranging from the smallest lamps of 25 watts to the largest of 200 watts. The story is made more complete by removing the old lamps and measuring other sizes as shown in Table 1 and Fig. 1. With no lamps in the feed alley for several farm stables, the 60-watt lamp spaced in the central or litter alley at intervals of four stalls in stable 6F gave almost the same lighting at the milking point[2] as did the 100-watt lamps spaced from 4½ to 5 stalls in stable 8F,

[2]For the most part, reference to light readings in this paper are for the milking point in the stall and adjacent to the cow as otherwise noted.







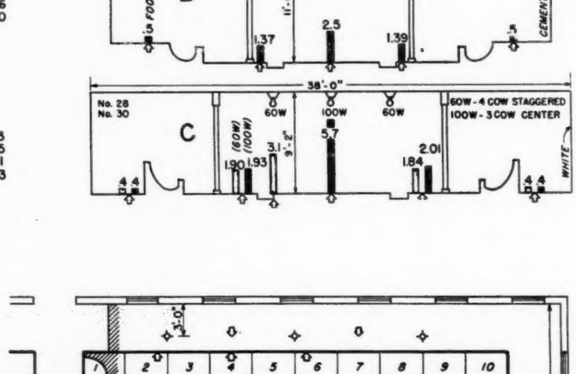


Fig. 1 (Upper left) Effect of lamp sizes and spacing in two farm stables, 6F and 8F. Illumination in alleys and at milking point in stalls is given in foot-candles. Fig. 2 (Upper right) Variation of illumination in foot-candles, in various positions across three dairy stables using central lighting. A – 100 and 200-watt lamps spaced 4½ to 5 stalls apart. B – 100-watt lamps with three-stall spacing. C – first trial with 60-watt lamps and four-stall spacing staggered over the gutter; second trial with 100-watt lamps and three-stall central spacing. Fig. 3 (Lower left) Comparative illumination with cows facing out (above, Stable 1F), and facing in (lower chart, Stable 19F), using 40, 60, and 100-watt lamps. Fig. 4 (Lower right) Plan of experimental barn showing positions of lamps. Arrows indicate light reading positions. Circles show positions of original lamps with enclosing globes, about 4½ stalls apart. Squares indicate spacings 5 stalls apart, and triangles, 3 stalls apart. Lamp cords were extended from staggered arrangement for positions under girder and over the backs of cows

TABLE 1. USE OF LIGHT IN FARM DAIRY STABLES WITH RESPECT TO SIZES, SPACINGS, AND POSITIONS OF LAMPS

	Lamp spacing and size						Foot-candles							Alley lamps and foot-candles			
	Spacing,						Left side			Right side			Ave.	Litter[1]		Feed[1]	
Barn	cows	feet	Size, watts	Line, volts	No. of lamps	No. of stalls	Range		Total[2]	Range		Total	per stall	No. of lamps	Range	No. of lamps	Range
1	3	10.3	40	119.0	5	32	0.2	0.7	7.0	0.1	0.8	7.7	0.46	5	0.5-0.8	0	0.1-0.3
			60	118.0	7	32	0.4	1.3	15.0	0.3	1.5	14.9	0.93	5	1.0-1.5	2	0.6-1.5
			60	118.0	5	11	0.8	1.2	4.0	1.0	1.2	06.8	.96	5		0	
			100	118.0	7	32	0.9	3.0	31.7	0.7	2.8	28.5	1.88	5	2.4-3.3	2	0.6-3.0
			100	118.0	5	32	0.8	1.8	21.9	0.6	1.6	22.2	1.38	5	2.0-2.5	0	0.3-0.5
6	4 to	17.5															
	4.5	18.8	25	118.0	4	28	0.1	0.4	3.2	0.1	0.4	2.6	0.20	4	0.2-0.7	0	0.0
			40	117.5	4	28	0.2	0.5	5.2	0.3	0.5	4.9	0.36	4	0.7-1.0	0	0.1-0.1
			60	120.5	4	28	0.7	1.2	13.3	0.8	1.1	13.6	0.96	4	1.5-2.1	0	0.2-0.4
			100	119.5	4	28	0.8	1.6	17.6	0.7	1.5	16.7	1.23	4	2.5-3.4	0	0.4-0.5
8	4.5	15.8	60[3]	114.8	3	28	0.1	1.0	9.9	0.1	0.8	7.8[4]	0.63	3	0.9-1.5	0	0.2-0.3
	to 5	17.5	100	112.5	3	28	0.1	1.5	15.2	0.1	1.0	10.3	0.91	3	1.4-2.8	0	0.2-0.3
			150	111.5	3	28	0.1	2.5	23.7	0.1	1.7	17.0	1.45	3	2.4-4.0	0	0.4-0.5
			200[3]	109.5	3	28	1.7	3.7	34.6	0.1	2.5	25.2	2.13	3	3.5-5.5	0	0.6-0.8
14	6.5	22.0	60	120.5	3	34[5]	0.2	1.0	14.0	0.1	1.0	10.1	0.71	3	0.2-2.5	0	0.2-0.3
	to6.3	22.7	100	119.5	3	34	0.3	2.1	24.1	0.1	1.7	17.5	1.22	3	0.5-5.7	0	0.4-0.4
17	5	20.0	60		5	32[6]	0.3	0.8	8.9	0.3	0.9	8.3	0.53	3	0.5-1.2	2	0.2-1.2

[1]Between and under lamps
[2]Sum of all stalls
[3]115-volt lamps, all others 120-volt
[4]Lights on one side, 1 ft off center
[5]18 cows on left and 16 cows on right
[6]17 cows on left and 15 cows on right

with an average of slightly less than one foot-candle. The variations of the individual stalls may be noted by reference to Fig. 1.

The feed alley readings for 100-watt lamps in stable 8F, with high-front mangers, were less than those in 6F with sweep-in type of manger. It is also of interest to note that a higher average illumination was later obtained (up to 4.06 foot-candles) in several other tests, with different spacing but with the same total rated wattage or even less, in spite of the usual increased output of lumens per watt for the larger lamps (Table 2). The arrows shown in Fig. 1 and subsequent figures represent positions of readings. These arrows are omitted where the reading was taken directly under the lamps.

Fig. 2 shows somewhat similar comparison of lamp sizes, but with the vertical section taken across the stable. Because of the central position of the litter carrier track in this stable, lamps on one side are one foot off center. The effect shows up in Fig. 2 and is present in Fig. 1. An exact comparison is not possible because of the variables such as reflecting surfaces of walls, height of ceiling, and other minor construction factors.

Each of the cross sections in Fig. 2 contains data on 100-watt lamps. It is of interest to study these together with those presented in Table 2. The lower cross section represents data obtained at the experimental barn and permits a comparison of two arrangements of lamp spacings, that of 100-watt lamps in the litter alley centrally spaced, three cows or 12 ft apart, with that of the four-cow staggered spacing and over the gutter line. Further discussion of this arrangement will follow.

The readings taken directly below the 100-watt lamp in the three sections are essentially equal for the upper and lower cross sections, but are noticeably lower in the middle cross section. High ceilings and low reflection factor are effective but not measured.

Cows Facing In vs. Facing Out. It is difficult to locate stables in Maryland where the cows face a central feed alley, and the tests made in the few found were unsatisfactory for purposes of comparison. Low voltage made it necessary to discard the data from one of these. The data shown in Fig. 3 were obtained in two well-lighted stables, 1F and 19F. In stable 1F, Fig. 2, cows faced outward, and the lamps in the central feed alley were spaced three cows

TABLE 2. TESTS OF LIGHTS IN EXPERIMENTAL BARN WITH VARIED POSITION AND SIZE OF LAMPS, WITH AND WITHOUT REFLECTORS (ABRIDGED)

	Lamp spacing and size				Foot-candles							Foot-candles and alley lamps						
					Left side, cows 1-10			Right side, cows 11-20				Litter		Feed		Manger[1]		
Test	Spacing, cows	Size, watts	Line, volts	No. of lamps	Min.	Max.	Total[2]	Min.	Max.	Total	Ave. 1-20	No.	Range	No.	Range	2	4	6
1R[3]	4C[4]	100	118.5	4	0.7	1.2	10.5	0.8	1.5	10.7	1.06	4	1.5-4.5	0	0.0	0.5	0.3	0.2
4	Do	40	118.0	3	0.3	0.6	4.9	0.5	0.7	5.7	0.54	3	0.7-1.1	0	0.0	0.3	0.2	0.2
5	Do	40		7	0.3	0.9	5.5	0.3	0.7	4.9	0.52	3	0.7-1.0	2-2	0.4-2.0	2.5	1.0	0.5
6	Do	40		9	0.5	0.8	6.7	0.6	1.1	7.8	0.72	3	1.0-1.5	3-3	0.3-2.4	0.5	0.4	0.5
9	Do	60	119.0	3	0.5	0.8	6.8	0.5	0.8	6.8	0.68	3	0.7-1.8	0	0.0-0.0	0.2	0.2	0.3
11	Do	60	121.5	7	0.7	1.3	10.0	0.7	1.4	11.2	1.06	3	1.3-2.3	2-2	0.7-3.6	4.0	1.7	0.7
7	Do	100		3	1.4	2.1	16.5	0.8	2.1	15.5	1.60	3	3.0-4.7	0	0.0-0.3	0.1	0.2	0.3
8	Do	100		7	1.1	2.8	20.1	1.3	2.8	19.5	1.98	3	3.5-5.1	2-2	1.2-6.6	8.7	3.0	1.3
12	3C	60		4	0.7	1.1	9.2	0.8	1.2	10.3	0.98	4	1.9-3.3	0	0.1-0.1	0.4	0.2	0.3
14	3C	60	121.0	8	0.8	1.7	13.2	1.0	1.8	13.3	1.32	4	2.3-3.5	2-2	0.8-3.3	4.8	1.6	0.8
30	3C	100	119.0	4	1.0	2.6	19.3	1.3	2.7	20.9	2.01	4	4.1-5.7	0	0.2-0.4	1.2	0.9	1.4
19	5C	60		3	0.6	1.3	8.6	0.6	1.0	8.1	0.84	3	1.1-3.0	0	0.0	0.2	0.2	0.3
27	4S	40		6	0.6	1.2	9.6	0.4	1.3	8.5	0.90	6	1.5-1.7	0	0.1-0.2	0.3	0.3	0.4
28	4S	60		6	1.1	2.6	19.0	1.1	2.5	17.8	1.84	6	3.0-3.1	0	0.2-0.4	0.6	0.7	0.7
29	4S	100		6	1.2	5.2	33.8	1.6	4.7	32.4	3.31	6	5.5-5.8	0	0.4-0.6	1.0	1.0	1.1
36R	4S	60		6	0.9	3.3	22.6	1.2	3.2	20.5	2.16	6	3.5-3.7	0	0.3-0.3	0.7	0.8	0.7
37R	4S	100	119.5	6	1.1	6.1	39.5	2.3	6.2	41.8	4.06	6	5.2-6.3	0	0.5-0.5	1.3	1.2	1.3

[1]Readings taken at top of manger at feed alley; No. 4 at center of manger, but No. 2 and No. 6 near partitions.
[2]Sum of meter readings for 10 stalls.
[3]"R"—reflectors or enclosing globes used.
[4]Letter "C" in this column denotes central spacing of lamps, and "S" staggered lamps over gutter line. All stalls are 4 ft wide.

or $10\frac{1}{2}$ ft apart. In 19F the cows faced in. Both stables had sweep-in type mangers. Stable 19F had exceptionally clean walls. The ceiling and the area above the window sills were painted with a high-gloss white enamel, and that below the sills was painted black. This stable also had concealed lamps in R. L. M. reflectors level with the ceiling line (at a height of 10 ft at the litter alley) and with a four-cow spacing.

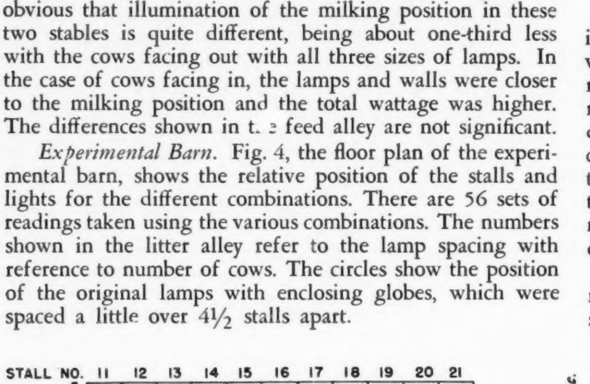
These are the major construction differences, yet it is obvious that illumination of the milking position in these two stables is quite different, being about one-third less with the cows facing out with all three sizes of lamps. In the case of cows facing in, the lamps and walls were closer to the milking position and the total wattage was higher. The differences shown in the feed alley are not significant.

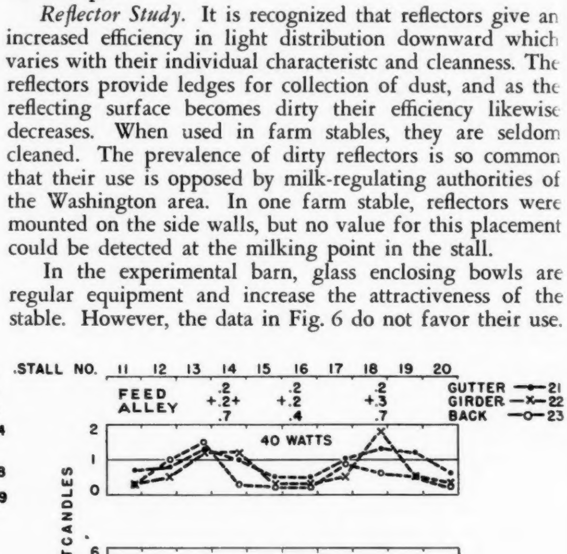
Experimental Barn. Fig. 4, the floor plan of the experimental barn, shows the relative position of the stalls and lights for the different combinations. There are 56 sets of readings taken using the various combinations. The numbers shown in the litter alley refer to the lamp spacing with reference to number of cows. The circles show the position of the original lamps with enclosing globes, which were spaced a little over $4\frac{1}{2}$ stalls apart.

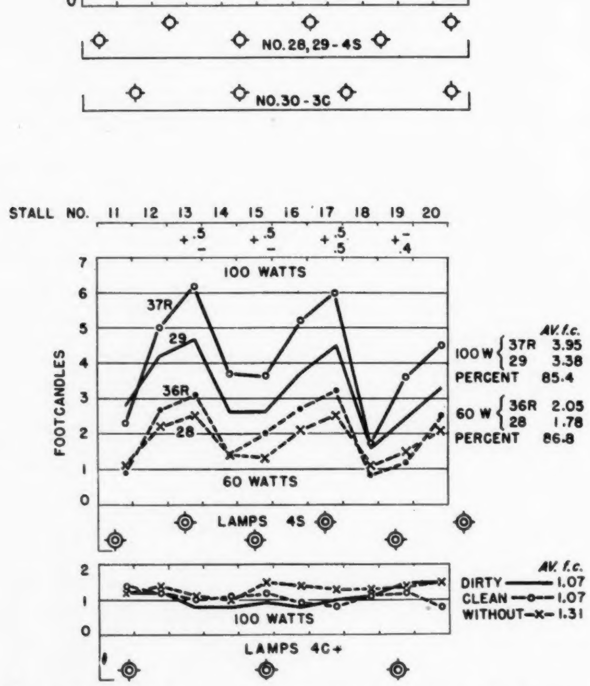
Central vs. Staggered Arrangement. Curves shown in Fig. 5 permit a limited comparison of two arrangements of lamps and their effectiveness. Tests 29 and 30 show that the 100-watt lamps and the four-cow staggered arrangement give higher stall illumination than the three-cow central arrangement. If we compare the averages, it is noted that the six 60-watt lamps give almost the same illumination as that for three-cow spacing using four 100-watt lamps.

Reflector Study. It is recognized that reflectors give an increased efficiency in light distribution downward which varies with their individual characteristc and cleanness. The reflectors provide ledges for collection of dust, and as the reflecting surface becomes dirty their efficiency likewise decreases. When used in farm stables, they are seldom cleaned. The prevalence of dirty reflectors is so common that their use is opposed by milk-regulating authorities of the Washington area. In one farm stable, reflectors were mounted on the side walls, but no value for this placement could be detected at the milking point in the stall.

In the experimental barn, glass enclosing bowls are regular equipment and increase the attractiveness of the stable. However, the data in Fig. 6 do not favor their use.







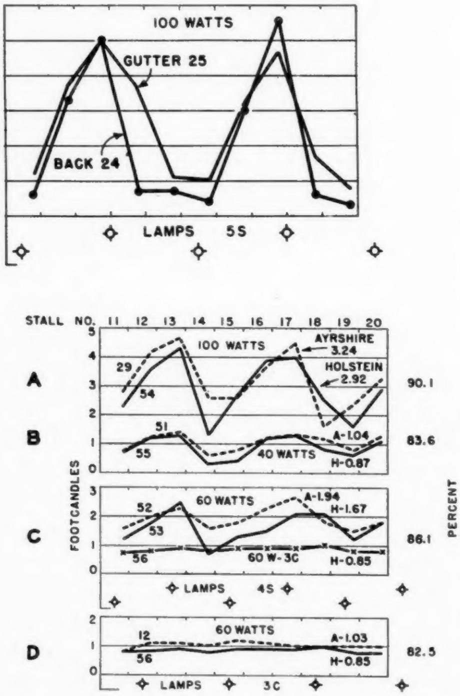


Fig. 5 (Upper left) Comparative illumination of central and staggered arrangements of 60 and 100-watt lamps. Fig. 6 (Lower left) Comparative illumination of shallow reflectors, enclosing globes, and bare lamps. Upper chart shows a comparison of 60 and 100-watt lamps with and without 14-in shallow reflectors ("R" after test number indicates reflectors). Lower chart compares 100-watt lamps bare and with clean and dirty enclosing globes, spaced 4 stalls apart. Fig. 7 (Upper right) Effect of lamp positions. Upper chart compares stall and feed alley illumination with 40-watt lamps placed over gutter, under girder, and over back of cow. The lower chart compares gutter and back positions using 100-watt lamps. Fig. 8 (Lower right) Effect of color of cows on illumination. A – 100-watt, B – 40-watt, C – 60-watt lamps, all staggered, and D – 60-watt lamps with central spacing. Figures on the right show percentage of illumination with dark-colored cows compared with 100 per cent for light-colored cows

The bottom chart compares them in the condition in which they were originally found with that after they had been cleaned and with bare lamps with the globes removed. The latter gave the best illumination. Referring to Fig. 6, the average foot-candles for clean versus dirty glass shows no difference, but the curves show that clean globes are better. The average of the data is unduly affected by cow No. 20 being out of normal position.

Standard 100-watt lamps with 14-in shallow-bowl reflectors were also tried and the results shown in curves at top of Fig. 6. Here again reference to the averages does not tell the complete story, although there is a difference of about 15 per cent in favor of the use of reflectors for both 60 and 100-watt lamps.

Lamp Position. Having compared the efficiency of lighting arrangement with respect to staggered lights over the gutter with that of centrally placed lamps, it is of interest to compare two other positions with respect to the cow as shown in Fig. 7.

The upper set of curves using a 40-watt lamp, revealed a higher illumination in the feed alley because of its nearness, when placed over the back of the cow and 2 ft in front of the girder. However, the shadows cast and the lower illumination at the milking point showed this position to be not very satisfactory and the position under the girder was even less effective. In fact, when the 100-watt lamps were tried, this arrangement was so obviously undesirable that no further trials were made. However, these curves are inadequate to convey the true condition of the shadows which must be observed in the stable.

Dark vs. Light-Colored Cows. It is of interest to note the characteristic difference between the two breeds which were studied in the same stalls by the interchanging of cows. The Holsteins for the most part were unusually black for the breed and the Ayrshires were mostly white, thus permitting a contrast of the two colors. Fig. 8 shows consistently higher foot-candles at the milking position for the three sizes of lamps (40, 60, and 100 watts) and differs from 10 to 18 per cent in illumination. Some individual Holsteins were 1 to 2 in higher than the Ayrshires. There was considerable difference in weight in some stalls between the two breeds and only a slight difference in others. In stalls 16 and 20 the difference was 500 and 400 lb, respectively, while in stalls 11 and 18 the difference was 50 and 75 lb. The difference in size appears to be a less dominant factor than that of color.

For convenience in comparison of light arrangement, test 56 of part D is superimposed on part C, making the contrast more evident for the two positions of lights with a 60-watt lamp. It is noted that the foot-candles for the light-colored cows are in general higher than for the dark cows.

SUMMARY

Most farmers want good stable lighting and will use it if some one will show them how to obtain it. All stables require some artificial light at chore time. The observations of present common practices and the tests made with a view to improving them have been briefly reviewed in this paper. The studies are incomplete and the data not entirely analyzed, but the high lights of these tests have been presented.

Most of the comparisons have been made at the milking point, and alley lamp readings have in many cases been omitted for convenience of illustration. Adequate light at the rear of the cow is most important in promoting cleanliness of the cow and in the production of clean milk.

In stables where the feed for individual cows is weighed, more illumination in the feed alley is needed than that used in the ordinary stable. The feed alleys in the experimental barn used in these tests do not have lamps as regular equipment. The illumination provided by the center lamps is inadequate to give the desired satisfaction. Tests 5, 8, 11, and 14 in the abridged Table 2 show how this condition may be improved.

Observations made show a need of 2 foot-candles or more for close readings of the ordinary dairy scale. In the ordinary feed alley 0.3 to 0.5 foot-candles or more are used, but this is inadequate to enable one to distinguish the tines of a fork on top of a clump of hay, although the bright wood handle may be readily seen.

The majority of dairy farmers want better lights in their stables. The Maryland survey indicates that many are satisfied with approximately one foot-candle of light at the milking point. Our studies show that higher levels of illumination can be easily obtained with efficient use of 60 or 100-watt lamps. The difference in cost between poor and mediocre light and that of good lighting is so small that few will hesitate to improve their lighting if they are shown how they may obtain it.

The Role of Nickel in the Production of Farm Tools

(Continued from page 444)

ing. As a rule a small amount of nickel (0.50 to 0.75) is added to a normal carbon and silicon content iron as insurance against chilling. Farm tool clutch plates are also alloyed to provide a close grain, higher strengths, and better wear resistance. A typical farm tool clutch plate iron contains 0.75 to 1.00 per cent nickel and 0.30 to 0.50 per cent chromium.

Ni-Hard. There is a group of farm tool parts such as grinding burrs, disk separation spools, and plow points, which have been made of low silicon iron of the chilled or white type where high surface hardness for wear resistance is desired. Improvement of the wear resistance, strength, and hardness of this iron has been accomplished by additions of alloys in sufficiently large amounts to render the base iron martensitic on ordinary slow cooling in the mold. This is accomplished by alloying the white iron base with about 4.50 per cent nickel and 1.50 per cent chromium as shown in Table 14. The resultant iron is produced under the trade name of Ni-Hard. Various hardness ranges can be obtained by control of total carbon content as indicated. Although the values shown are for chill castings, Ni-Hard of a high carbon content, when sand cast, has developed hardnesses in the neighborhood of 650 Brinell, at which hardness it has outperformed ordinary chilled white iron at 500 Brinell about 3 and 4 to 1 in seed and feed grinding burr applications, such as that shown in Fig. 22.

Ni-Hard disk separation spools are in test at present, and at various times plow points have been experimentally produced. It is also being used for specially designed ensilage choppers. It is suggested at this point that it might merit investigation for corn picker snapping rolls, either of the full-hard sand-cast or modified Ni-Hard chill cast.

Table 15 is a summarizing of property requirements met in various farm tool iron parts by the addition of nickel, either alone or in combination with other alloys.

In closing, it is again called to your attention that this paper should be considered an outline, as each item discussed could serve as a separate subject for a paper in the light of the extensive research which has been carried out in the past several years.

Progress Report on Wire Fence Exposure Tests

By J. W. Crofoot
MEMBER A.S.A.E.

IN 1934 the American Society for Testing Materials, with the cooperation of the American Society of Agricultural Engineers, initiated exposure tests of various types of wire fences, primarily to determine the effects of such factors as base metal composition, gage size, type of coating, and weight of coating on the life of farm fences.

Eleven locations scattered throughout the United States were selected for test sites, seven of which are established at land-grant colleges and universities. The wires exposed for test at these various sites consist of uncoated copper-bearing steel, zinc-coated copper-bearing steel, corrosion-resistant steel, copper-covered steel, and lead-covered steel. The number of samples of zinc-coated steel wire is far in excess of any of the others, and includes wires with weights of zinc coating from 0.2 oz to 3 oz of zinc per square foot of wire surface.

Five types of fencing materials have been used. They are farm field fencing, unfabricated wire, barbed wire, wire strand, and chain link fence.

Since these test fences have been up for only a little over two years, you will doubtless be interested only in a summary of results so far, which is contained in more or less direct quotations from the A.S.T.M. "Wire Test Report."[1]

The following paragraphs summarize the findings from visual examination for corrosion at the test plots:

1 On zinc-coated specimens extensive rusting has occurred at Pittsburgh in two years, and some at Sandy Hook and Bridgeport. The wires rusted at Pittsburgh involve those carrying a coating up to about 0.8 oz of zinc per square foot, at Sandy Hook 0.45 oz, and at Bridgeport 0.35 oz. In the cases of zinc-coated wires which have not yet developed rust—even those in the same weight of coating classes—there are characteristic tendencies for some to become greyed in appearance after a relatively short exposure and for others to retain a metallic or bright appearance. This tendency to become grey early should not be interpreted as a forecast of early development of rust.

2 No rusting has occurred on any of the copper-covered specimens in two years.

3 All of the lead-coated wires have developed a rusted or rust-like appearance in the pattern of speckles, seemingly at pinhole points in the coatings. In field inspection of these lead-coated wires it is difficult to judge the extent of actual corrosion of the base metal. This is particularly true if a wire has a rough surface which has become discolored by spread of the iron corrosion products originating at pinholes.

4 No significant corrosion has developed on uncoated corrosion-resistant steel wires at any location in two years.

The following paragraphs summarize indicated trends of the tensile strength data:

1 Ordinary zinc-coated wires do not show significant losses of strength until after rusting of the base metal has started.

2 The order of corrosiveness of test locations from that of most severe to mildest is Pittsburgh, Sandy Hook, Bridgeport, and State College, Pa. From the data at hand all of the other seven locations seem milder than at State College, but definite ratings are not yet certain.

3 The copper-bearing uncoated wires are corroding less rapidly than the ones having lower copper content at Pittsburgh. Thus far the differences do not appear significant at the other locations.

4 There is no clear cut indication at this time that the lighter gage uncoated wires are being penetrated more rapidly than those of heavy gage.

The following paragraphs summarize the findings from weight-loss specimens:

1 There is a tendency for the wires of lighter gages to lose coating somewhat faster than those of heavier gages.

2 There appears to be no specific difference in the corrosion ratings of wires exposed on the east side of the test racks as compared to those exposed on the west side.

As previously stated, this summary is not complete. Those results are presented which would seem to be of most interest to you.

Presented before the Farm Structures Division at the annual meeting of the American Society of Agricultural Engineers at State College, Pa., June 17, 1940. The author is with the Cooperative G.L.F. Farm Supplies, Inc., and a representative of the A.S.A.E., with B. A. Jennings, on the A.S.T.M. Committee A-5 (Corrosion of Iron and Steel).

[1]A 113-page summary of the work of Subcommittee 8 (Fencing) of Committee A-5 (Corrosion of Iron and Steel), American Society for Testing Materials.

Disk Plow Use in Certain Areas

DISK plows predominate over moldboard plows in Louisiana and Arizona but the reverse is true in Texas where a few standard disk plows are used in the central part of the state. The question of whether the direct connected or trailing type disk plow predominates depends on the make rather than area or condition. The predominating type of plow in an area is the one that will be used most commonly for turning cover crops in that area. The replies from this area show no general shift in the type of tillage equipment being used.

Disk plows are not popular in the area of North Dakota, South Dakota, Nebraska, Kansas, Colorado, Wyoming, Idaho, and Utah except the vertical disk plow is used in the wheat growing section of Western Kansas and the area in North Dakota where wheat is combined. Replies indicate most of the disk plows in other areas have been introduced as experimental units or because of soil conservation payments. The trend, however, especially in the wheat growing area, is away from the disk plows and toward the use of duck foot cultivators, subsurface tillers, and damming listers. The reasons given are that these tools leave the surface in a condition to resist wind erosion and to absorb a maximum amount of moisture.

Only 250 to 300 standard disk plows and practically no vertical disk plows are sold in the area of the New England States, New York, Pennsylvania, Virginia, West Virginia, New Jersey, Maryland, and Delaware each year. This is a small percentage of the plows sold. Most of them seem to be used in an area around Harrisburg, Pennsylvania. Problems mentioned most often when using moldboard plows are breakage in stony land, clogging when working in combined stubble, and lack of understanding of hitching principles and plow adjustments. Objections to disk plows are incomplete coverage of trash and rough condition of the turned sod. The implement people report that they expect a shift toward disk equipment.—*Extracts from a report of the A.S.A.E. Committee on Soil Preparation and Tillage, June 1940.*

NEWS

A.S.A.E. Fall Program Outlined

FOLLOWING the general arrangement of the meeting last year, and in line with the majority of expressed preferences, this year's Fall Meeting of the American Society of Agricultural Engineers, in Chicago, will be held again during the week of the International Livestock Exposition, December 2 to 6, at the Stevens Hotel.

The first day will be devoted to council and committee meetings. Tuesday and Wednesday, December 3 and 4, will feature simultaneous sessions of the Farm Structures and Power and Machinery Divisions. The Rural Electric and Soil and Water Conservation Divisions are paired off for simultaneous sessions, December 5 and 6.

Division programs have been built up by the coordinated efforts of the respective division chairmen. Chairmen and vice-chairmen of the divisions are, respectively, for the Power and Machinery Division, A. W. Turner and A. J. Schwantes; Farm Structures Division, Wallace Ashby and G. B. Hanson; Rural Electric Division, J. P. Schaenzer and A. V. Krewatch; and Soil and Water Conservation Division, I. D. Mayer and H. S. Riesbol.

POWER AND MACHINERY

A symposium on "Equipment, Methods, and Costs of Collecting Crop Residues" holds the starting place on the Power and Machinery Division program, Tuesday morning, December 3. Contributors scheduled are R. B. Gray, F. D. Jones, O. F. Scholl, J. B. Davidson, V. J. Mueller, and Stanley Russell. Following up on this line of thought are papers on "Studies in the Utilization of Farm Wastes," by Robert P. Beasley, and "Power Alcohol in Tractors and Farm Engines," by E. L. Barger.

Engineers in the farm equipment industry, an editor in this field, and a large user of farm machinery will open discussion of "Some Engineering Implications of High-Speed Farming" in a symposium which will constitute the afternoon session. Those slated to open up the subject are E. J. Baker, Jr., C. J. Scranton, Elmer McCormick, B. Gwynne Burr, and D. C. Heitshu.

Individual papers will feature the Wednesday morning program. They are "The Harvesting and Storage of Grain Sorghums," by F. C. Fenton; "Results of Corn Row Spacing Experiments," by E. V. Collins; "Equipment for Corn Cultivation," by C. K. Shedd; and "The Effect of Shape on the Draft of 14-inch Moldboard Plow Bottoms," by I. F. Reed.

JOINT PROGRAM ON GRASS SILAGE

By way of advancing their mutual and interrelated interests in the engineering of grass silage, the Power and Machinery and Farm Structures Divisions will join forces in a symposium on the subject Wednesday afternoon and evening, December 4.

T. E. Woodward will open the session with consideration of "The Relation of Agronomic, Biochemical, and Nutritional Factors to Engineering Problems and Farm Practices." This paper will be discussed by Geo. R. Shier. H. E. Besley and W. R. Humphries will follow with "Machinery for Harvesting and Handling Grass Silage." "Grass Silage Machinery Development" is to be reported by F. W. Duffee.

The two preceding papers will be discussed by representatives of farm equipment manufacturers.

In the evening J. R. McCalmont and H. E. Besley will report on "Results of Studies of Grass Silage Storage Problems." A technicolor motion picture, "The Story of Grass Silage," showing methods, equipment, and structures for ensiling grass crops, is to be shown through the courtesy of the Portland Cement Association. The session will then be thrown open to general discussion.

FARM STRUCTURES

Building materials will be featured in the opening session of the Farm Structures Division, Tuesday morning, December 3. Reports and papers scheduled include "Objectives of the Committee on Specifications for Farm Building Materials," by G. B. Hanson; progress report of subcommittees on paint and steel, by Don Critchfield and E. D. Anderson; "Purchase of Fencing on Specification," by Dr. S. A. Braley; "New Developments in Grain Storage," by R. A. Glaze; and "Dry Wall Construction," by Clark Heritage.

Farm housing and remodeling are on the afternoon program. "The Missouri Type of Low-Cost House" will be explained by J. C. Wooley. "A Crib Type Low-Cost House" is to be described by Deane G. Carter. "Remodeling of Farm Buildings" will be handled by Max J. LaRock and O. E. Brunkow. Ray Crow is scheduled for a contribution on "Sheet Steel for Roofing, Siding and Ceiling Purposes."

Wednesday morning subjects include "The Effect of Land Utilization Programs on Farm Building Construction," by W. A. Rowlands; "A National Program to Promote Farm and Rural Building Construction," by Bernard L. Johnson, and "The Need for More Farm Building Specialists," by Kirk Fox and K. J. T. Ekblaw.

For the afternoon and evening the Division will meet jointly with the Power and Machinery group for the grass silage program as previously outlined.

NATIONAL DEFENSE

The Society is sponsoring a roundtable on agricultural engineers' contribution to National defense, which will be held Thursday evening, December 5.

RURAL ELECTRIFICATION

Engineering of farm electric equipment and its use will be featured in the Rural Electric Division. In its opening session, Thursday morning, December 5, refrigeration will be the lead-off subject. "The Design of Farm Freezing Units," by Richard L. Witz, will be followed by "The Freezing and Storage of Foods in Farm Cabinets," by Geo. W. Kable. Following an intermission I. P. Blauser will present "An Economic Analysis of Large and Small Feed Grinding Units for Dairy Farms." "Heating Water Troughs Electrically," is to be discussed by F. D. Yung.

"New Ideas in Rural Electrification Engineering" will be covered in a session Thursday evening. A paper on the subject by M. M. Samuels is to be discussed by B. P. Hess and H. L. Garver.

Friday morning's session is to include papers on "An Insecticide Dispersing Machine," by C. W. Veach; "What Farm Electrification Needs," by Ben D. Moses; "Results of Tests of a Soil Pasteurizer," by Andrew Hustrulid; and "The Electrolytic Method of Incubating Eggs," by Santiago R. Cruz.

F. R. Elliott will discuss "The Installation and Operation of Jet Pumps"; J. R. Ditchman, the "Application of Ultraviolet and Infrared Light to Farm Uses"; and H. J. Gallagher, "Rural Electric Equipment Displays and Dealer Cooperation," in the closing session, Friday afternoon.

JOINT PROGRAM ON IRRIGATION

Irrigation equipment and practices will occupy the combined attention of the Rural Electric and Soil and Water Conservation Divisions Thursday afternoon, December 5. Subjects and speakers scheduled are "Handling Water on Irrigated Farms," by Ivan D. Wood; "Developing New Farms on Irrigation Projects," by C. H. Wilson; "Distribution of Water and Spacing of Sprinklers for Irrigation," by J. E. Christiansen; and "The Factor of Judgment in Supplemental Irrigation," by F. E. Staebner.

SOIL AND WATER CONSERVATION

In its opening session Thursday morning, December 5, the Soil and Water Conservation Division will give attention to papers on "Determination of Soil Conservation Data for Field Use," by Dwight D. Smith; "Farm Dirt Moving as Applied to Pond Building," by W. A. Harper; "Water Conservation on the Great Plains," by F. C. Fenton; and "Terrace Dimension Changes and Movement of Terrace Ridges," by L. H. Schoenleber.

Contributions scheduled for Friday morning, December 6, are "Crops and Dams Protect a Watershed," by Emerson Wolfe; "Results of Studies at the Great Plains Experimental Watershed," by Latimer L. Kelly and John A. Allis; "Recent Developments in Controlled Drainage," by David H. Harker; and "The Availameter and Its Use in Soil Moisture Control," by R. B. Allyn, and R. A. Work.

This division's program will close with the Friday afternoon session featuring "The Erosion Equation," by R. W. Gerdell; "Recent Improvements in Open Ditch Maintenance Practice," by Edwin A. Krekow, and "A Study of Old Farmer-Built Terraces in the Southeast," by Arvy Carnes and W. A. Weld.

A.S.A.E. Meetings Calendar

December 2-6—Fall Meeting, technical divisions, The Stevens, Chicago, Ill.

February 5-7, 1941—Southern Section Meeting, Atlanta, Ga.

June 23-26, 1941—Annual Meeting, Knoxville, Tenn.

Who's Who in Engineering

ENGINEERS throughout the country will soon receive material, questionnaires, and previously printed records bearing on the new (5th) edition of "Who's Who in Engineering." This work is being revised under the editorship of Dr. W. S. Downs, with qualifications established by a committee of the engineering profession, composed as follows: Andrey A. Potter (chairman), dean of engineering, Purdue University; Col. L. B. Lent (vice-chairman), executive secretary, American Engineering Council; Frederic L. Bishop, secretary, S.P.E.E.; C. E. Davies, secretary, A.S.M.E.; H. H. Henline, national secretary, A.I.E.E.; T. Keith Legare, secretary, National Council State Boards of Engineering Examiners; A. B. Parsons, secretary, A.I.M.M.E.; George T. Seabury, secretary, A.S.C.E.; Stephen L. Tyler, secretary, A.I.C.E.; and John A. C. Warner, secretary and general manager, S.A.E.

The publishers have been favorably known over a long period. "Who's Who in Engineering" has proved its worth and is commended to the careful consideration of the individual engineer, particularly as ready reference to personal professional data is now of pressing importance in all phases of national defense.

Fertilizer Application Committee Meeting in Chicago

THE annual meeting of the National Joint Committee on Fertilizer Application will be held at the Drake Hotel in Chicago on December 2, according to an announcement recently issued by Mr. H. R. Smalley, director of soil improvement work of the National Fertilizer Association, who is general secretary of the Committee. The Joint Committee at present consists of 51 representatives of the following five technical and trade organizations: American Society of Agricultural Engineers, American Society of Agronomy, Society for Horticultural Science, Farm Equipment Institute, and National Fertilizer Association. In addition numerous research workers and others serve on special committees and otherwise assist in the Joint Committee activities.

G. A. Cumings, agricultural engineer, division of farm mechanical equipment, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture, who is chairman of the A.S.A.E. Committee on Fertilizer Application, was elected general chairman of the Joint Committee for the current year. Election to this position is not only an honor to Mr. Cumings, but it is a noteworthy credit to the Society.

The Joint Committee through coordinated effort of its various groups has not only promoted nation-wide research work in fertilizer application methods, but it has also contributed much in the development of improved fertilizer-distributing machinery and the establishment of more effective farm practices. On account of the rapidly expanding activities on fertilizer placement during the past 10 years, the Joint Committee has found it advisable to create eight subcommittees consisting of one general and four regional committees on fertilizer placement research, and subcommittees on fundamental problems, publicity, and special machinery for research.

Any member of A.S.A.E. is privileged to attend the annual meeting of the Joint Committee. In fact, attendance of all members interested in fertilizer application is urged. The program will consist of reports by the various subcommittees on the activities and accomplishments during the year, presentation of the results of fertilizer-placement research, including the movement of fertilizer salts in the soil, and a symposium on root development and its relation to fertilizer application problems.

Well-Known Dairy Engineer Passes

JOHN T. BOWEN, senior electrical engineer, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture, passed on October 17. Mr. Bowen was a former member of A.S.A.E. and had been connected with the U. S. Department of Agriculture for a great many years, his activities being practically entirely in the dairy engineering field. His book on dairy engineering has been widely used as a textbook in that field.

Washington News Letter

from AMERICAN ENGINEERING COUNCIL

CIVIL SERVICE EXTENSION VOTED BY CONGRESS

EVENTUAL inclusion within the merit system of an estimated 200,000 positions in the federal service is possible if the House and the Senate, each of which has approved the Ramspeck bill, can compose a dispute over its method of application. This measure authorized the President, by executive order, to cover into the Civil Service almost all federal agencies now not subject to its provisions. Notable exceptions are all employees of the Works Projects Administration and the Tennessee Valley Authority, assistant U. S. district attorneys, and positions filled by Presidential appointment and approved by the Senate.

Holding up the bill at the time of writing is a disagreement over a proposed House amendment that would bar from its benefits present personnel from states over their quota under the apportionment plan, which is designed to spread federal employment in the District of Columbia among the states in proportion to their population. The District of Columbia, Maryland, and Virginia are chronically far above their quotas, and a number of other states exceed it from time to time. The Senate position is that, although the principal of apportionment is sound, its application to thousands of present employees would involve insoluable administrative difficulties and work to the disadvantage of the government by depriving it of the services of many experienced employees.

EMPLOYMENT OF ENGINEERS IN DEFENSE PROGRAM

Engineers who wish to offer their services to the federal government in the defense program have three main avenues of approach, (1) direct employment, (2) engagement on a consulting basis, and (3) as an employee or consultant of a contractor having a government contract. A brief outline of how employment in these three categories may be accomplished follows:

Direct Employment. With relatively few exceptions, employment in government departments, bureaus, independent agencies, and the like is under civil service rules and regulations. Competitive examinations produce so-called eligible lists, from which names are certified to those government agencies making requests. Personnel is being added to several agencies directly concerned with the defense program, such as War, Navy, and the Defense Commission, but most appointments are being made from Civil Service eligible lists already in existence. And many jobs are being handled by calling reserve officers of the Army and Navy to active duty.

Consulting Basis. The engagement of engineers on a consulting basis is handled by each government agency in accordance with rules and regulations of long standing, although in a few cases recent simplifications to expedite procedure have been made. In general, compensation is on a per diem basis and only in exceptional cases, does the rate exceed $25.00 per day. Many government agencies at times use consultants, but at the present time and in carrying out the defense program, the Army, Navy, and the Panama Canal are the principal agencies now taking on engineering consultants.

Applications for consulting work in the Army are being handled by the recently appointed Construction Advisory Board consisting of Francis Blossom, Forrest S. Harvey and J. F. C. Dresser. Communications to this board should be addressed to 1125 Munitions Building, Washington, D. C. Requests for consideration should be accompanied by a full statement of experience records, especially records of jobs accomplished. A similar list for the Navy is being compiled by Lt. A. D. Hunter, Bureau of Yards and Docks, Navy Department, Washington, D. C.

As is generally known, the ASCE, ASME, AIEE and some other engineering bodies have sent questionnaires to their members to compile information respecting those individuals or firms who are available for consulting work. The information gleaned from this questionnaire is now filed with the more important government agencies. Members of engineering societies should address their communications to the secretaries of their respective societies.

Contractors' Staffs. Contractors on defense work will of course engage their own employees and consultants. The policy adopted by the government is to award contracts, whether for the consulting services of engineers, or for construction, to those qualified to handle the work who reside in the region where it is to be done. In a few cases, the construction contract also includes the design, but this is exceptional. However, engineering firms who are also contractors might well make their qualifications known to the Construction Advisory Board named above.

It should be understood that the National Defense Advisory Commission itself awards no contracts, but merely serves as a coordinator to assist the regular Federal agencies in carrying out their individual programs. *(News continued on page 454)*

Personals

Dale L. Bidwell is joint author with B. C. Langley, of "Hydrologic Studies—Compilation of Rainfall and Runoff from the watersheds of the Texas Agricultural Experiment Station, Substation No. 7, Spur, Texas, 1928-38." It was prepared under the direction of *C. E. Ramser.*

E. K. Bonner, Jr., employed as a designer for the A. B. Farquhar Company, has resigned to accept employment as an engineer with the LeRoy Plow Company, LeRoy, New York.

Walter M. Carleton has accepted a one-year appointment as extension rural engineer of the Kansas State College. He was previously rural engineer for the Kansas Power and Light Company.

C. F. Chowenhill, until recently project engineer for the U. S. Soil Conservation Service at Lander, Wyoming, has been transferred to the U. S. Department of the Interior, his grade (assistant agricultural engineer) and position remaining the same.

George W. Curtis has been appointed manager of the Milwaukee division of the Timken Roller Bearing Company, and will have supervision of industrial and automotive bearing sales as well as alloy steel sales activities of this division. He is widely known for his work in the application of Timken bearings to all types of automotive, agricultural, and industrial equipment, and also for his contributions to the design of power transmissions.

Arnold A. Dudley is engaged in rural electrification work for the Powell Valley Electric Cooperative, Jonesville, Virginia. He is a 1940 agricultural engineering graduate of the Virginia Polytechnic Institute.

Everett C. Kneece, a sales representative of the International Harvester Export Co., at Bombay, India, has recently been transferred to Rio de Janeiro, Brazil.

Harry Miller has been appointed to head the research department of the Doane Agricultural Service of Saint Louis. His activities will be devoted largely to developing processes for the utilization of agricultural products by industry.

R. H. Reed is the agricultural engineering contributor to an extension mimeograph on "Drying Hybrid Seed Corn", published by the University of Illinois.

James B. Robinson, Jr., is now employed in mold design work by the Goodyear Tire and Rubber Co. His address is 815 Ardmore Ave., Akron, Ohio.

R. Earl Storie reports on "Natural Land Divisions of Santa Cruz County, California: Their Utilization and Adaptation", in California Agricultural Experiment Station Bulletin 638. It contains a colored center spread map of the county with 19 color variations showing land classifications.

David S. Weaver, extension agricultural engineer and head of the division of agricultural engineering at North Carolina State College, has been appointed by the governor of the state as chairman of the North Carolina Rural Electrification Authority, to which activity he will henceforth devote a large part of his time. Mr. Weaver's friends will see in this appointment well-earned recognition of his standing in the field of rural electrification, and will congratulate him on the honor which has come to him.

John W. Wolfe has received an appointment as junior agricultural engineer with the U. S. Soil Conservation Service and has been assigned to the CCC camp which the Service maintains near Chamberlain, South Dakota. He was previously graduate assistant in agricultural engineering at the University of Idaho.

Ivan D. Wood has taken a one-year leave of absence from his duties as extension agricultural engineer, University of Nebraska, to serve as district engineer with the Denver office of the Farm Security Administration. In this capacity he will supervise all engineering activities of the FSA in North and South Dakota, Nebraska, Kansas, Montana, Wyoming, Colorado and possibly additional states. Most of his work will be with irrigation projects under the Case-Wheeler Act.

Student Branch News

NEBRASKA

By Winston Hedges

FORTY-SEVEN students, faculty members, and guests were present October 8, at a special dinner held in the Student Union Building, honoring Prof. E. E. Brackett, president of the American Society of Agricultural Engineers.

Short talks were given by Prof. Brackett and by our student branch president, Earle Cox, who presented the Farm Equipment Institute cup award for 1939-40 to the group. This cup is awarded annually by the A.S.A.E. to a student branch in the United States or Canada having the most improved activities record as evidenced by a written report submitted for judgment in competition with other student branches. This meeting was the premier showing of the award since it had been kept hidden by President Cox since his return from the annual meeting at Penn State.

Guests included Harry L. Dempster, president of the Dempster Mill and Manufacturing Co., and president of the Farm Equipment Institute; Dean Ferguson of the engineering college; Dean Burr of the agricultural college; and Earl Gaffney, sales manager of the Dempster Mill and Manufacturing Co.

Raymond Heller and Harold Mizner, agricultural college students, were honored by the group for the splendid job they did on the agricultural engineering float they prepared for which we received second prize in the Farmers' Fair parade.

On October 16, Prof. E. A. Grone of the department of engineering mechanics gave our group an illustrated talk on Boulder Dam. The slides and discussion of the surrounding territory were especially interesting because they showed clearly the problems that had to be solved before the actual construction of the dam was started. Mr. Grone also discussed the pouring and curing of the concrete that makes up the main body of the dam, and the installation of electrical generators.

At the beginning of this school year we found forty sophomores, juniors, and seniors enrolled in our department, and there are several men taking the agricultural engineering course who have not changed their registrations. We are looking forward to a big year.

An interesting side light on our group might be focused on our secretary-treasurer. We don't know whether it is the office or the men we choose for it. We elected Lyle Choat a year ago last spring, and the next fall he showed up with a wife. The same thing happened in the case of our present secretary-treasurer, Ernest Munter. Does anyone know a good auditor?

PENNSYLVANIA

By Karl Norris

THE A.S.A.E. Student Branch of Pennsylvania State College started off with the best foot forward this year, when it held a get-acquainted cabin party on September 27. The freshmen were the guests of the upperclassmen at the party, and the main object was to be sure everybody became acquainted with everybody else. This was very neatly accomplished by first having a softball game in which the seniors and freshmen played the juniors and sophomores. The scoring was so free that no accurate account could be kept; so both sides claimed a victory. Next came the meal of baked beans, hot dogs, cider, and ice cream.

Immediately after the meal a get-acquainted game was played in which each person gave his name and his home town, and then each of the twelve freshmen competed for a prize by giving the name and home town of everybody he could.

The second meeting of the Branch was held on October 14, in the new agricultural engineering building. It was announced that there are 41 ag. engineering students this year, consisting of 5 seniors, 11 juniors, 11 sophomores, and 14 freshmen.

The Branch voted to join the parent society as individual members as has been done in the past.

Karl Norris, Ausmus Marburger, and Prof. A. W. Clyde gave reports on the A.S.A.E. Industry Seminar which they attended in September.

Plans are being formulated to hold a meeting every two weeks, and have a speaker from some company concerned with agricultural engineering for each meeting.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the October issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Oral A. Brown, associate engineer, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture. (Mail) Irwinville, Ga.

G. A. Burson, Jr., assistant supervisor, Farm Security Administration, U. S. Department of Agriculture. (Mail) Box 708, Albany, Ga.

Hiram D. Cabassa, agricultural engineering aide, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 863, Rio Piedras, Puerto Rico.

W. L. Walker, 804 Mill St., Springfield, Ark.

Hugh E. White, instructor, agricultural engineering department, North Dakota Agricultural College, Fargo, N. D. (Mail) 902 14th St., N.

TRANSFER OF GRADE

Earle K. Rambo, instructor, agricultural engineering department, University of Tennessee, Knoxville, Tenn. (Junior Member to Member)

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Copies of publications reviewed may be procured only from the publishers at the addresses indicated.

LAND-SAVING PLANS FOR CONSERVATION IN THE PACIFIC SOUTHWEST, U. S. Dept. Agr., Soil Conserv. Serv., 1939, Region 10, pp. 24, figs. 23. Illustrations and brief accompanying statements illustrate the nature of and the damage done by sheet erosion and gullying, and show also the means which may be used to prevent such damage or to check its progress where it has begun. Irrigation water as an erosive agent is briefly mentioned.

SERIES OF FACTORS INVOLVED IN STUDY OF EROSION CONTROL, *T. N. Jones*. Miss. Farm Res. (Mississippi Sta. A. and M. College), 3 (1940), No. 4, p. 7. Factors emphasized as of special importance in farm water disposal are (1) soil type and slope, (2) cropping system, (3) terraces, (4) terrace outlets, (5) woods, (6) ponds, etc. Effects of interplanting *Crotalaria* species with corn on 2.5, 5, 7.5, 10, and 12.5 per cent slopes are shown in terms of the losses resulting from a rainfall of 2.74 in during 2.5 hr. The *Crotalaria* had reached a height of 6 in at the time of the storm. It lessened the losses of soil very markedly as compared with those from the plats under corn alone.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE MASSACHUSETTS STATION, Massachusetts Sta. (Amherst) Bul. 369 (1940), p. 45. These have included cranberry storage investigations, by C. I. Gunness, H. J. Franklin, and C. R. Fellers; work on frost protection on cranberry bogs (use of a wind machine), by Gunness; and poultry-house investigations (electric brooders in insulated and noninsulated colony houses), by Gunness and W. C. Sanctuary.

THE PERMEABILITY OF BUILDING PAPERS TO WATER VAPOUR, *J. D. Babbitt*. Canad. Jour. Res. (Ottawa), 18 (1940), No. 5, Sect. A, pp. 90-97. Various types of building papers roughly grouped into 13 different classes were tested as to their permeability to water vapor. It is apparent that a continuous film of some impermeable material, such as wax or asphalt, is necessary if the paper is to be impervious to water vapor, while the presence of the impermeable material as an absorbed phase in the paper is not sufficient. Evidence from this study indicates that diffusance is independent of such factors as thickness, weight, or type of paper.

PAINTS AND PLASTERS FOR RAMMED EARTH WALLS, *R. L. Patty*. South Dakota Sta. (Brookings) Bul. 336 (1940), pp. 39, figs. 22. Cement stuccoes satisfactory for ordinary stucco work were found satisfactory for application to rammed earth walls. The wall should season for several months, however, before stucco is applied, and for walls more than 8 ft in height bonding wire or mesh should be used, as on frame walls. Two inexpensive plasters which proved quite satisfactory on rammed earth walls were dagga-cement plaster and dagga plaster with an admixture of asphalt emulsion.

Paints on exterior rammed earth walls were generally disappointing. Only a comparatively small number of paint panels proved satisfactory. Good quality lead-oil paints have shown satisfactory results on high-quality walls only, for exterior work. Paints should be tried only after careful study of the paint-panel results and with a thorough knowledge of the soil used in the construction of the wall. Linseed oil and glue sizing proved equally satisfactory for priming coats for lead-oil paints, and possibly fish oil may be equally good. Priming coats that penetrate the wall were found definitely unsatisfactory. No transparent paint has been found satisfactory as yet. Linseed oil did little damage to the wall surface, but showed low durability. Other transparent paints, except some extremely temporary ones, damaged the wall deeply. Most good quality paints were quite successful on interior walls. Cold-water paints, with the exception of whitewash, were satisfactory. Common wall plaster was quite successful on interior walls, and nailing the scratch coat to the wall has been satisfactory on all panels tried.

It is further noted that "the most valuable and most practical admixture yet tried for rammed earth walls is ordinary sand. It may or may not contain a reasonable amount of coarse aggregate. Some coarse aggregate in the admixture will neither be an advantage nor disadvantage to the weathering quality of the wall nor to the success of the covering. A well-graduated sand and aggregate will increase the strength of the wall, slightly, over an admixture of sand containing uniform-sized particles."

THE EFFECT OF CLIPPING AND DRYING IMMATURE GRASSES ON THEIR YIELD AND CHEMICAL COMPOSITION, *M. W. Goodwin*. Delaware Sta. (Newark) Bul. 223 (1940), pp. 21, figs. 8. The experiments reported in this bulletin were carried out by means of a two-tray, batch drier, heated by an oil burner and provided with a fan driven by a 15-hp motor to draw the hot gases first through a tray of partly dried grass and then through another layer of fresh grass. The inlet temperature is thermostatically controlled at 250-300 F, and practically all the heat is utilized in evaporating moisture by the time the gases are exhausted into the air. The grass brought in from the field is forked into one tray, which is conveyed upon rollers into the oven. When the grass is half dried the tray is withdrawn, its contents are forked into the second tray, the first is refilled with wet grass, and the two are then drawn back into the oven. As soon as the moisture content of the herbage in the partly dried tray has been brought below 10 per cent, the drying is considered sufficient. A duplicate set of trays is provided on the opposite side of the dryer, one set being always in the oven while the grass is being transferred from the other. From 15 to 30 min are usually required for each stage of drying, depending upon the quantity of water to be evaporated. The baling, done immediately after cooling, was performed in a power baler capable of forming compact bales of about 125 lb each without pulverizing the dried grass.

The total cost of production was about $28 per ton under the experimental conditions obtaining.

The product retained its original green color. Comparative annual acreage yields of dry matter from frequently clipped artificially dried grass were greater than those of sun-cured hay. Frequent clipping of the immature grasses increased the acreage yields of protein from 40 to 60 per cent over that recovered by the usual haymaking procedure. Artificial dehydration preserved more than five times as much carotene as did field curing. Only insignificant losses of carotene occurred during the artificial drying and baling of immature grasses. Loss of carotene during storage in bales was found most rapid during the first few months, particularly in hot weather. While the loss averaged 50 per cent during the 10-mo experimental period, the final product still contained from two to five times as much carotene as was found in the hay at time of storage. Reduction of moisture of herbage below 10 per cent by artificial drying was valueless.

The study indicates that it is possible to produce in Delaware a high yield of a high-protein, low-fiber, and high-carotene feed from a grass and clover mixture, and that it can be well preserved by artificial drying followed by storage in bales.

SIMULTANEOUS PRODUCTION OF WOOD PULP AND THE CONVERSION OF THE NONCELLULOSIC CONSTITUENTS OF WOOD INTO ALCOHOLS, OILS, AND RESINS, *E. E. Harris and E. C. Sherrard*. (Coop. Univ. Wis.) U. S. Dept. Agr., Forest Serv., Forest Prod. Lab. (Madison, Wis.), 1940, R1218, pp. [4]. Wood chips of various species were hydrogenated at 1,000 or at 3,000-lb pressure in suspension and in an aqueous medium with the help of a nickel catalyst. Sufficient alkali (from 8 to 10 per cent or more of the weight of the wood) to keep the solution alkaline at all times was necessary to prevent the acidic substances formed from inhibiting the activity of the catalyst. Pulp of good quality, requiring only a mild chlorine treatment, was produced, together with methanol, propanol, propyl cyclohexane derivatives, and an oily resin. Data from experiments with aspen, maple, slash pine, and red gum are tabulated.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE NEBRASKA STATION, Nebraska Sta. (Lincoln) Rpt. [1939], pp. 46-49. These have included tractor testing and work on performance characteristics of rubber tires on tractors, adaptation of small electric motors to farm use (coop. U.S.D.A.), automatic electrical water systems, electrical water heating for livestock, methods of cooling milk on the farm and their effect on quality, the adaptability of electric hotbeds to farm use, adaptation of insulated electric brooders in uninsulated poultry houses, and mechanical equipment for the eradication of bindweed. *(Continued on page 458)*

Agricultural Engineering Digest

(Continued from page 457)

SOURCES OF HEAT FOR COTTON DRYING, *C. A. Bennett, V. L. Stedbronsky, and W. J. Martin.* U. S. Dept. Agr., Misc. Pub. 385 (1940), pp. 23, figs. 19. The advantages to both producer and ginner derivable from drying cotton before ginnings are briefly summarized, and figures showing the increasing use of driers (800, handling nearly 1,000,000 bales in 1938, as against only 15 driers handling about 25,000 bales in 1931) are stated.

Of the 3 heat sources now used, a survey made in 1938-39 showed 73 per cent of the driers reported upon using steam heat, 20 per cent using air-heating furnaces, and 7 per cent using waste heat from engines. The nature of the equipment needed for the use of these 3 sources of drier heat is discussed, and cost per bale, advantages and disadvantages in operation, and other characteristics are indicated for each method. Fuel for drying by steam heat is estimated to average a little over 16 ct per bale, for an air-heating furnace about 12 ct, and for engine waste heat, both that from the engine cooling water and that from the exhaust gases being utilized, slightly less than 6 ct per bale. In connection with the last-named source of heat, however, it is noted that there will often be need for a supplementary source of heat. Combinations of engine heat with other air-heating equipment are described and illustrated by photographs, diagrams, and, in part, by dimensioned drawings. Numerous experimental observations and recommendations with respect to economical and efficient set-up and operation are given in connection with the various forms of drier equipment dealt with.

SOME PRINCIPLES OF ACCELERATED STREAM AND VALLEY SEDIMENTATION, *S. C. Happ, G. Rittenhouse, and G. C. Dobson.* U. S. Dept. Agr., Tech. Bul. 695 (1940), pp. 134, pls. 16, figs. 19. This bulletin presents results of a study of the principles of stream and valley sedimentation under the influence of culturally accelerated soil erosion, a step in a research project of which the ultimate objective is a sound and scientific program to prevent or alleviate damage to valley resources by such sedimentation. The present report is based chiefly on detailed studies of sedimentation in the drainage basins of Tobitubby and Hurricane Creeks, in Lafayette County, Miss., representative of one of the areas of most severe soil erosion and associated sediment damage in the Gulf Coastal Plain. The first of the two main parts of the bulletin is devoted to a description of conditions in these valleys and their tributary drainage areas. In the second part, 45 principles developed by analysis of the results of the Tobitubby-Hurricane investigation and less detailed studies in other parts of the United States are outlined and discussed.

LINING IRRIGATION CANALS TO SAVE WATER, *O. W. Israelsen.* Farm and Home Sci., Utah Sta. (Logan), 1 (1940), No. 3, pp. 5, 11, figs. 2. Considering the welfare of all the people in an irrigated valley or state, the lining of irrigation canals is valuable (1) for saving of water for use in irrigation, (2) for reduction of the cost of drainage of irrigated land, and (3) for conservation of soil productivity. To the stockholders of a mutual irrigation company, however, the lining is valuable only to the extent that it saves water for the use of the stockholder irrigators. The drainage systems are usually not under the management or control of the irrigation company, and, therefore, the reduction of drainage costs does not directly influence the canal company officials. Likewise the lands that need protection against waterlogging and alkali concentration are frequently far removed from the canals that sustain seepage losses. At present the cost of lining must be justified largely, if not entirely, on the basis of the value of the water saved. The author analyzes the costs and savings involved in lining canals with cement concrete and reduces his results to a formula for estimating the justifiable cost per square foot of lining.

PLANS OF FARM BUILDINGS FOR SOUTHERN STATES. (Coop. land-grant colleges of Ala., Ark., Fla., Ga., La., Miss., N. C., Okla., S. C., Tenn., Tex., and Va.) U. S. Dept. Agr., Misc. Pub. 360 (1940), pp. 123, figs. 124. Dwelling houses, barns, and shelter, storage, and work buildings are covered. The plan, a section, and a sketch of the completed structure are accompanied in each instance by a brief description and a reference number to be given in ordering the working drawings. Such drawings are obtainable through the county agricultural extension agent or from the extension agricultural engineer at the address of the state college or university.

ELECTRICAL EQUIPMENT FOR USE ON FARMS BEING TESTED AT STATION. Farm and Home Sci., Utah Sta. (Logan), 1 (1940), No. 3, p. 2. The tests reported cover equipment for use in dairying, poultry raising, hog raising, and horticulture. The fund for this work was established by the Utah committee on the Relation of Electricity to Agriculture, a subdivision of the national committee. *(Continued on page 460)*

Agricultural Engineering Digest

(Continued from page 458)

EQUIPMENT FOR BURNING SULFUR IN EMPTY GREENHOUSES AND IN MUSHROOM HOUSES FOR THE DESTRUCTION OF MITES AND INSECTS, *O. K. Hedden and C. R. Neiswander.* (Coop. U.S.D.A.) Ohio Sta. Bimo. Bul. 204 (1940), pp. 63-72, figs. 8. The authors describe apparatus which can be constructed from steel barrels, the simpler of the two devices being a natural-draft burner which must be placed inside the building to be fumigated. Sulfur trays with suitable perforated bottoms are set one above and one below a charcoal-burning grate in which briquets are used. Placing two or three burning briquets in each of the two sulfur trays was found desirable to insure prompt ignition of the sulfur. A 50-lb sulfur charge was found to be best burned when 35 lb were placed in the upper and 15 lb in the lower tray. Such a burner required a metal shield between it and any nearby woodwork to obviate fire hazard.

A forced-draft burner of similar construction could be supplied with sufficient air (a fan delivering about 250 cu ft per minute being recommended) by a ½-hp gasoline engine or electric motor. This device gave better control, lessened fire risk by placing the combustion chamber entirely outside of the building, and permitted adding more sulfur through a funnel fitted into the top of the burner. The sulfur dioxide from this burner was blown into the building through a suitable length of 6-in stovepipe ending in a T with screen-covered openings. It was necessary to provide a movable baffle plate capable of being turned in front of the air inlet after the sulfur began burning rapidly, since exposing the burning sulfur to the direct draft burned or melted the metal trays. Construction of the forced-draft burner necessarily involves some welding. Drawings adequate for the construction of both types of burner are included.

The build-up of sulfur dioxide concentration was determined at the upper and lower bench levels in two experiments and at two points nearly at the same level in a third experiment, the data being presented in three graphs. Concentrations lethal to red spiders and their eggs were secured at all points where test leaves infested with these pests were placed, but the chemical determination of the concentrations attained and of the rates at which the concentration rose and fell indicated a necessity for the careful closing of all openings, especially those in the upper part of the building. Despite the fact that sulfur dioxide is heavier than air, it was shown to be more difficult to secure high concentrations of the gas in the lower than in the upper part of the structure under fumigation. It was concluded that 3 lb of sulfur per 1,000 cu ft should produce a concentration of sulfur dioxide amply sufficient to kill all forms of mite and insect life.

REMODELING USED MACHINERY FOR TRACTOR FARMING, *L. F. Larsen.* South Dakota Sta. (Brookings) Cir. 30 (1940), pp. 15, figs. 12. Several adaptations of machines designed to be horse-drawn, to permit their use with tractors, are described and illustrated by diagrams and photographs.

Using a stub tongue to attach the first of two binders directly to the tractor drawbar and a tongue truck on the second binder, the operator can hitch the two machines to work in combination by means of two chains or cables. The longer of these chains or cables must be passed through two slip joints under the front binder (an ordinary clevis can be so attached as to serve this purpose), and the evener bracket on the second binder must be removed, lengthened to about 32 in, and replaced inverted, bringing the end nearer the ground.

To provide for windrowing and drying in the windrow before using a combine, the author rebuilt an old binder into a right-hand windrower, suitable for preparing the grain for a combine having right-hand pick-up. It is also pointed out that any farmer who has an old header available will find that it makes a good windrower for a right-hand combine by merely removing the elevator.

COTTON PICKING MACHINERY: A SHORT LIST OF REFERENCES, *E. L. Day.* U. S. Dept. Agr., Bur. Agr. Econ., Econ. Libr. List 9 (1940), pp. 19. This reference list, superseding three previous typewritten lists, was compiled mainly from *Agricultural Economics Literature* (vol. 1, 1927, to vol. 13, 1939) and *Cotton Literature* (vol. 1, 1931, to vol. 9, 1939). A brief indication of the nature of each article cited is given.

Literature Received

THE BUYER'S GUIDE, 1940 edition. A directory of farm equipment manufacturers, listing about 800 companies, 834 classifications and sources of repairs, if any, for over 6400 old implement lines. Farm Implement News. Price not stated.